US012122654B2

(12) **United States Patent**
Fantappie et al.

(10) **Patent No.: US 12,122,654 B2**
(45) **Date of Patent: *Oct. 22, 2024**

(54) **WATER DISPENSING STATION**

(71) Applicant: **PepsiCo, Inc.**, Purchase, NY (US)

(72) Inventors: **Giancarlo Fantappie**, Rancho Palos Verdes, CA (US); **Diego Macrellino**, Torrance, CA (US)

(73) Assignee: **PepsiCo, Inc.**, Purchase, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **18/048,750**

(22) Filed: **Oct. 21, 2022**

(65) **Prior Publication Data**

US 2023/0054529 A1 Feb. 23, 2023

Related U.S. Application Data

(63) Continuation of application No. 16/875,975, filed on May 15, 2020, now Pat. No. 11,479,455.

(Continued)

(51) **Int. Cl.**

B67D 1/00 (2006.01)
B67D 1/08 (2006.01)

(Continued)

(52) **U.S. Cl.**

CPC ***B67D 1/0017*** (2013.01); ***B67D 1/004*** (2013.01); ***B67D 1/0058*** (2013.01);

(Continued)

(58) **Field of Classification Search**

CPC B67D 1/0017; B67D 1/004; B67D 1/0058; B67D 1/0855; B67D 1/0859;

(Continued)

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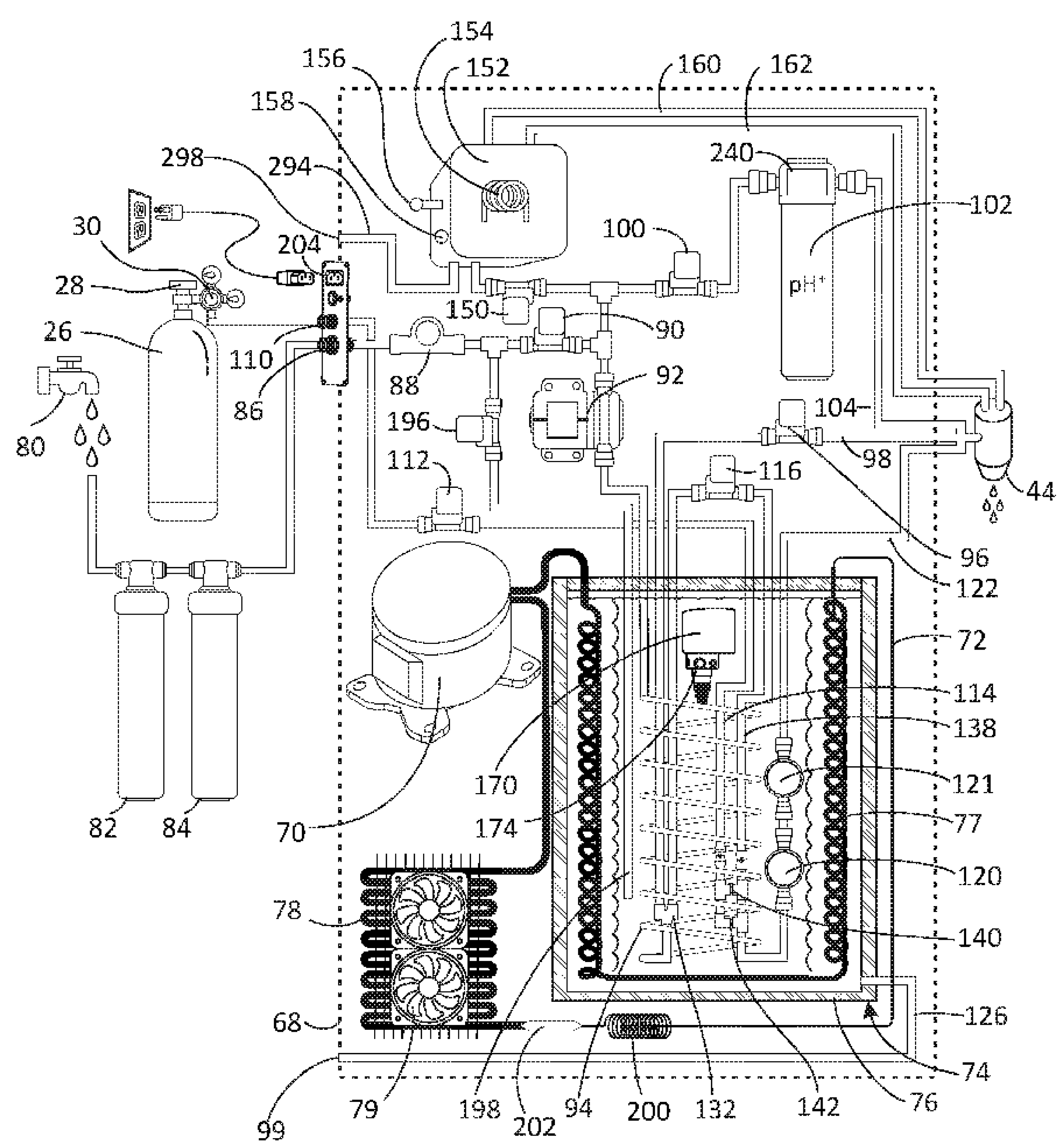
Primary Examiner — Bob Zadeh

(74) *Attorney, Agent, or Firm* — Sterne, Kessler, Goldstein & Fox P.L.L.C.

(57) **ABSTRACT**

A drink station is provided with an alkaline filter cartridge in fluid communication with an ambient temperature water line provide alkaline water, and with a chilled water mixed with the alkaline water at a spigot to provide chilled alkaline water. A hot water heating element is located below the spigot so hot water flows upward for dispensing from the spigot, with a vent line between the heating element and spigot helping hot water to flow from the spigot to the heating element. A refrigeration system and a carbonation system is also provided. The refrigeration system uses the ice-bank technology. A submersible agitator pump improves heat exchanged between ice-bank and water by forced convection. The agitator pump operating based on the temperature of the drinking water. A figure eight evaporator coil can provide two cylindrical ice banks and two chilled water coils to increase the chilled water capacity.

20 Claims, 37 Drawing Sheets



Related U.S. Application Data

(60) Provisional application No. 63/006,652, filed on Apr. 7, 2020, provisional application No. 62/849,796, filed on May 17, 2019.

(51) **Int. Cl.**
B67D 1/10 (2006.01)
B67D 1/12 (2006.01)

(52) **U.S. Cl.**
CPC ***B67D 1/0855*** (2013.01); ***B67D 1/0859*** (2013.01); ***B67D 1/0888*** (2013.01); ***B67D 1/0895*** (2013.01); ***B67D 1/10*** (2013.01); ***B67D 1/1279*** (2013.01)

(58) **Field of Classification Search**
CPC B67D 1/0888; B67D 1/0895; B67D 1/10; B67D 1/1279; B67D 1/007; B67D 1/0875; B67D 2210/00047; B67D 1/0864
See application file for complete search history.

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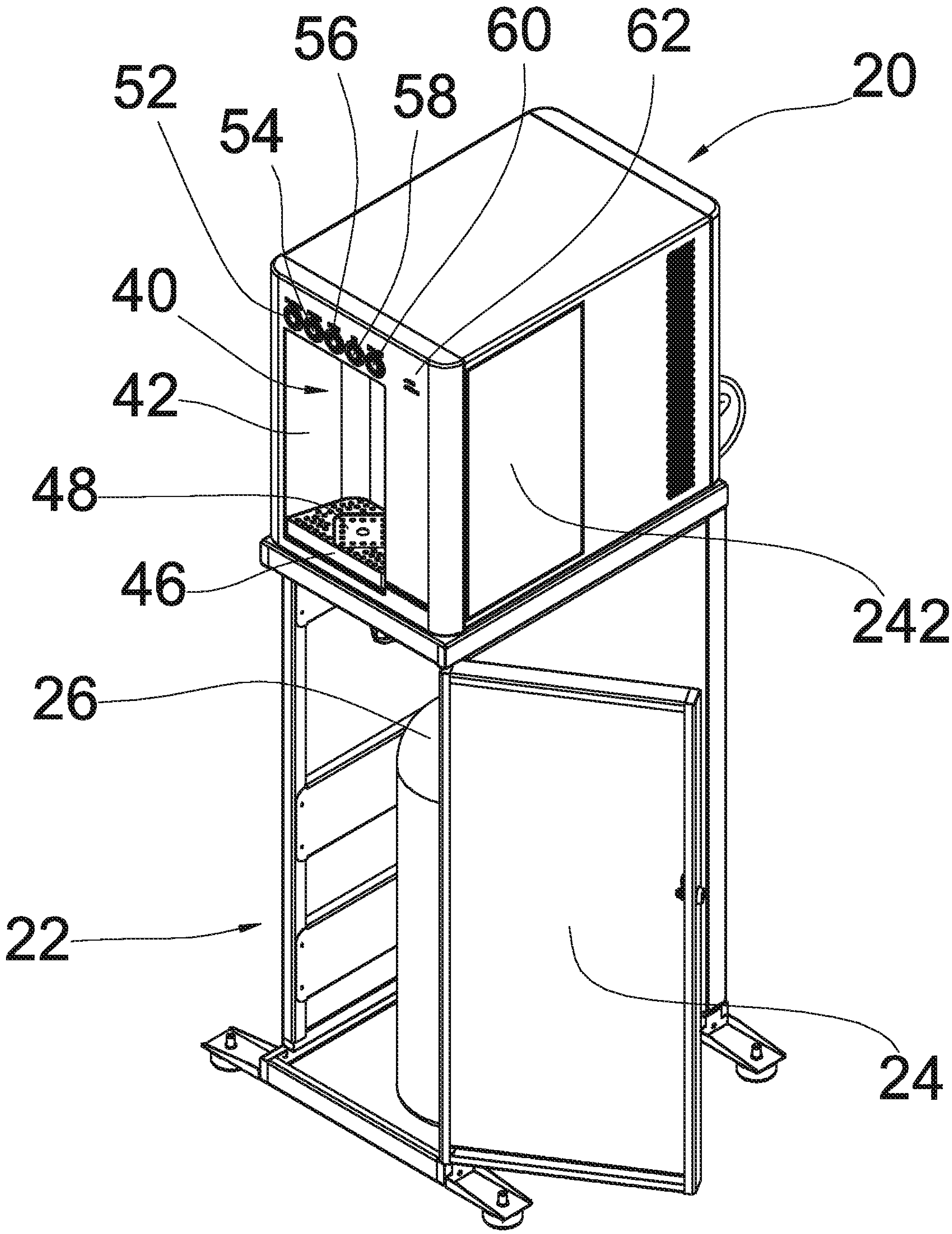


FIG. 1A

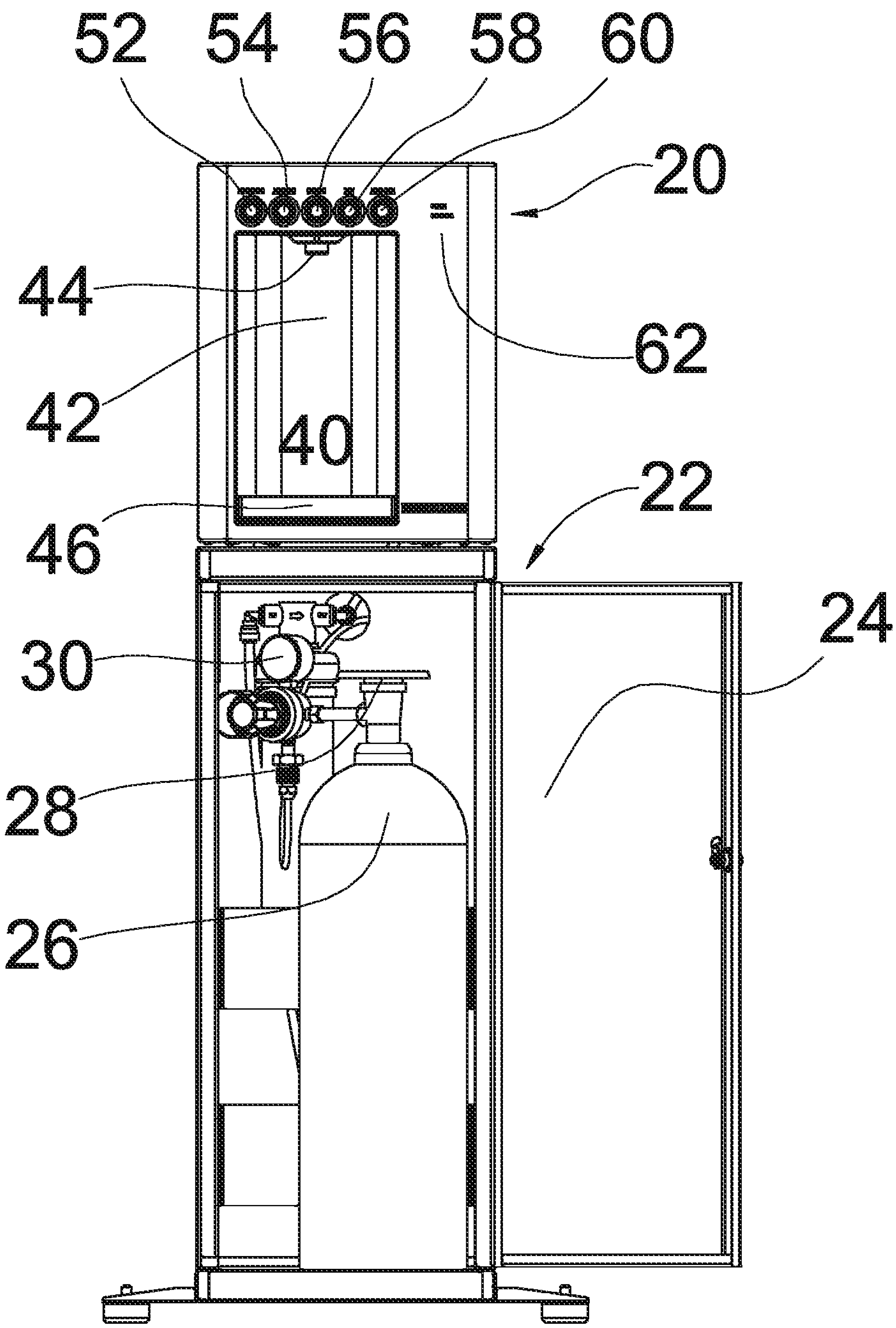


FIG. 1B

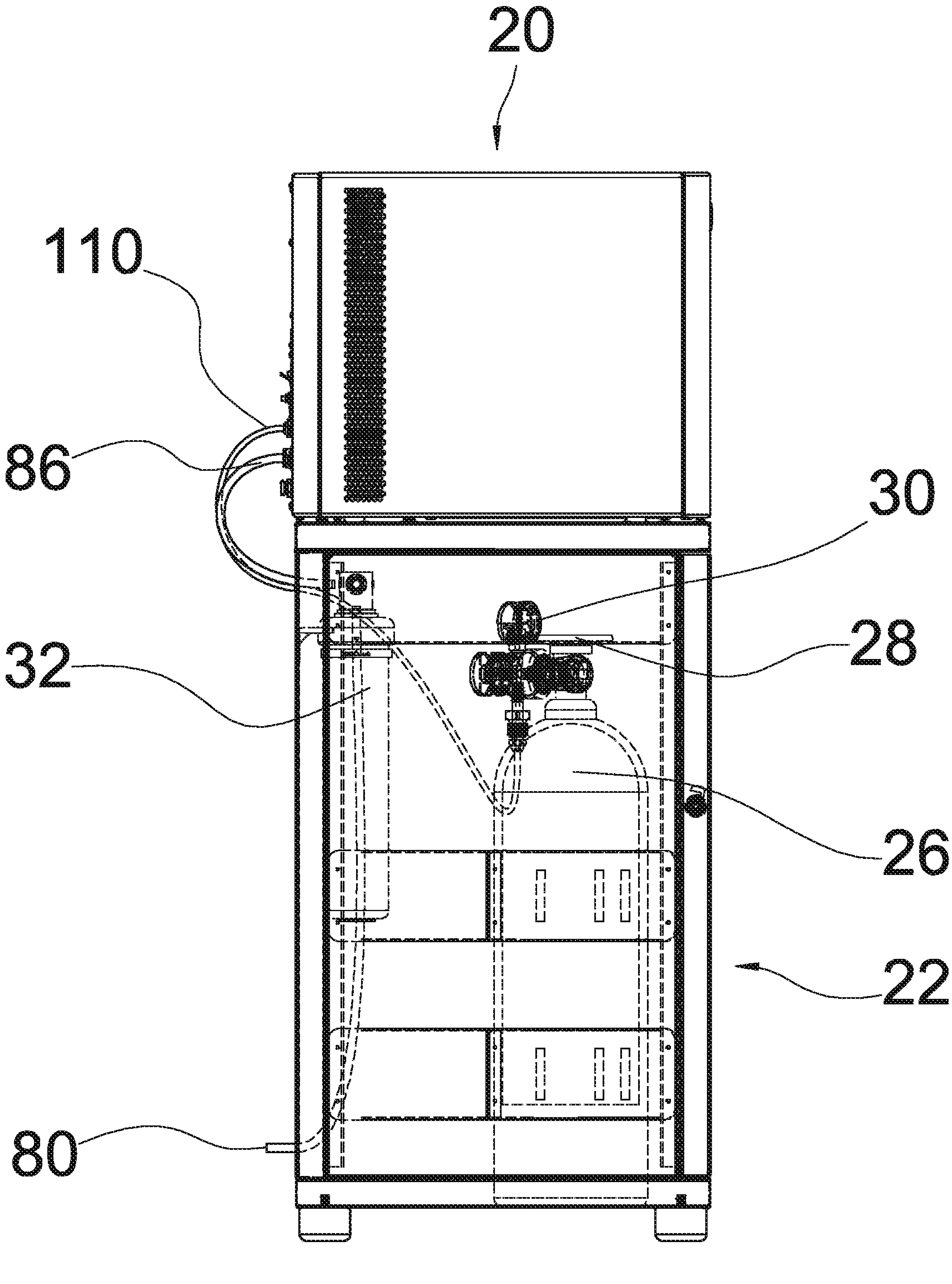


FIG. 1C

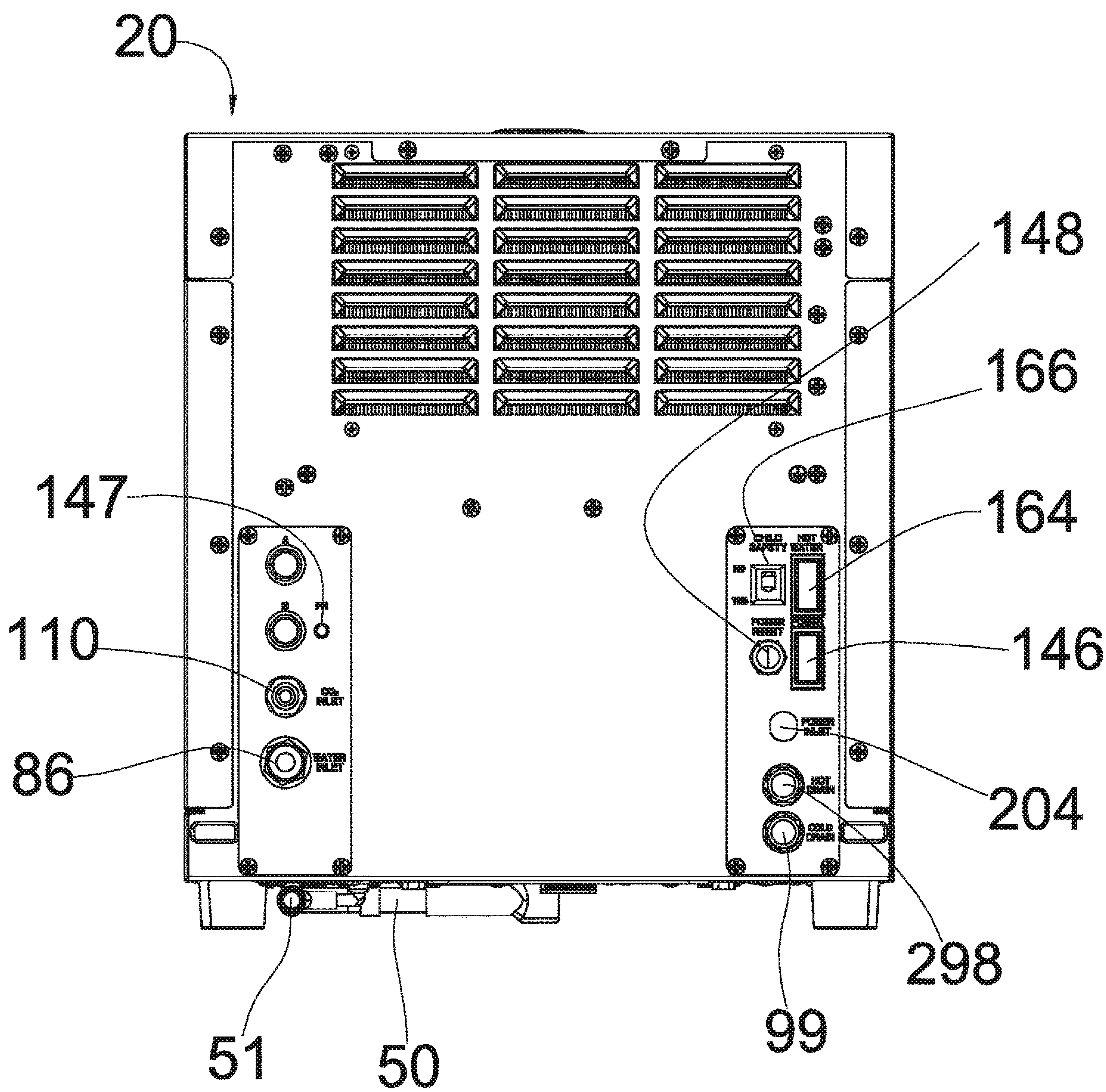
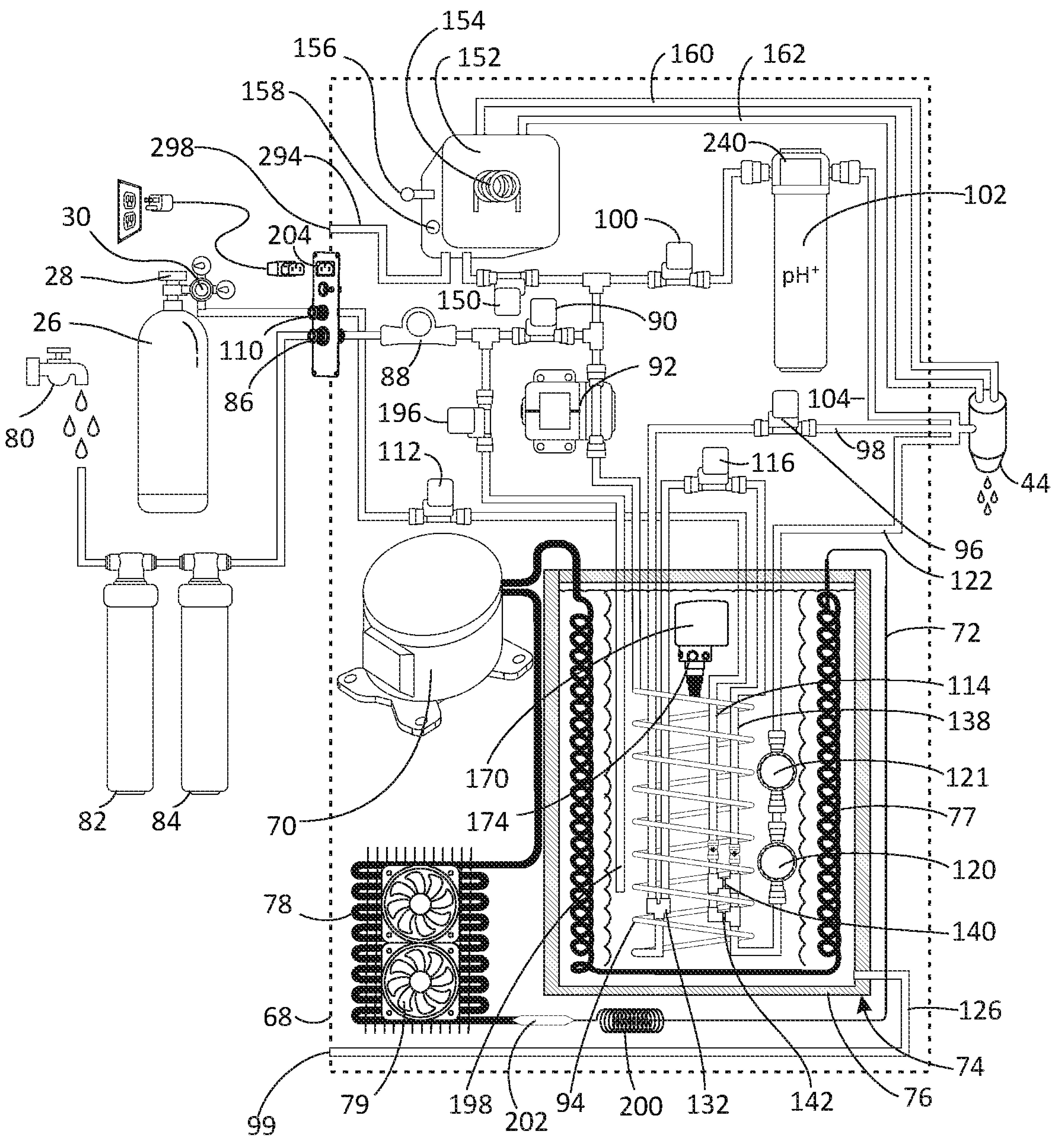


FIG. 1D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174
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FIG. 2A

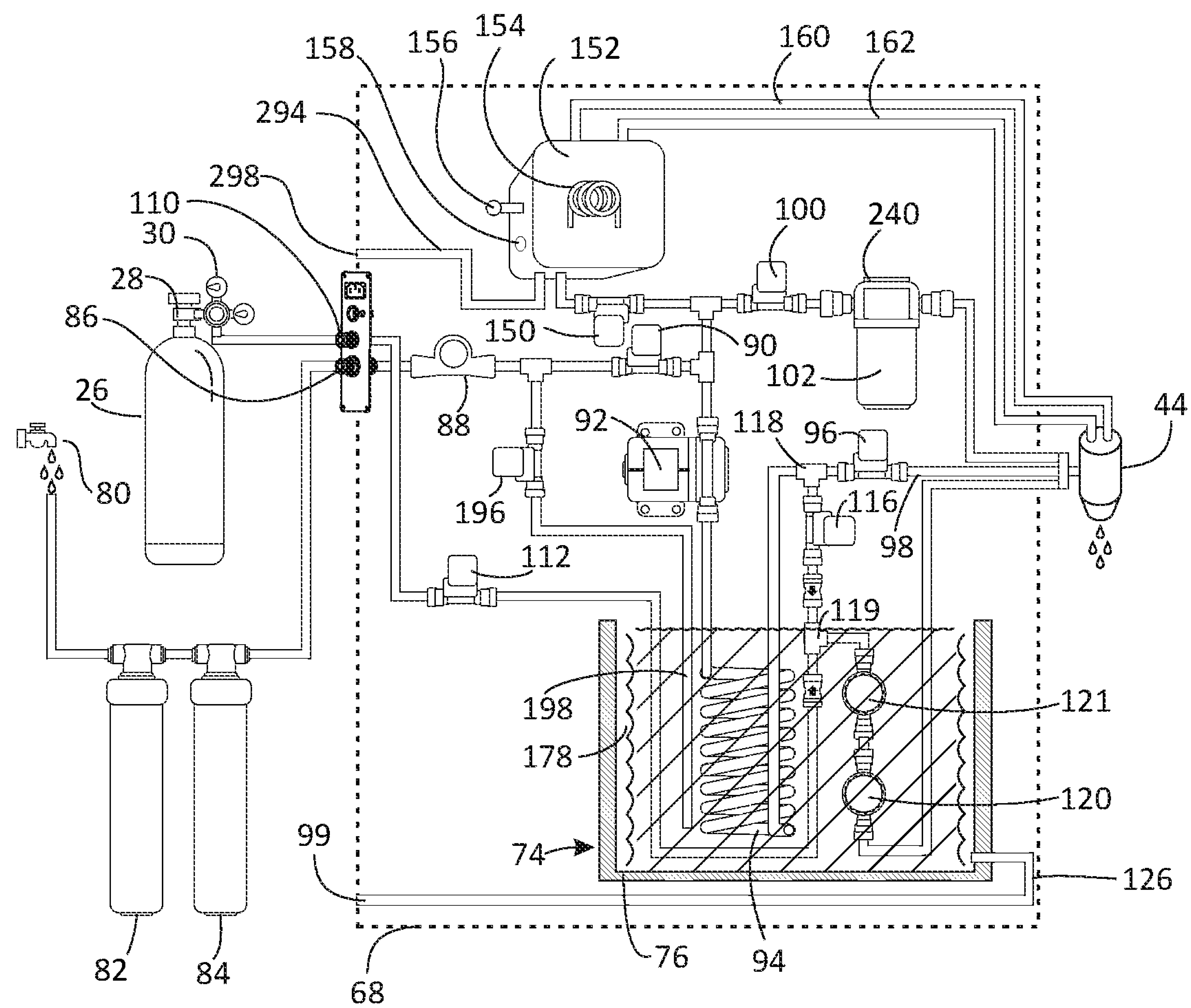
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FIG. 2B

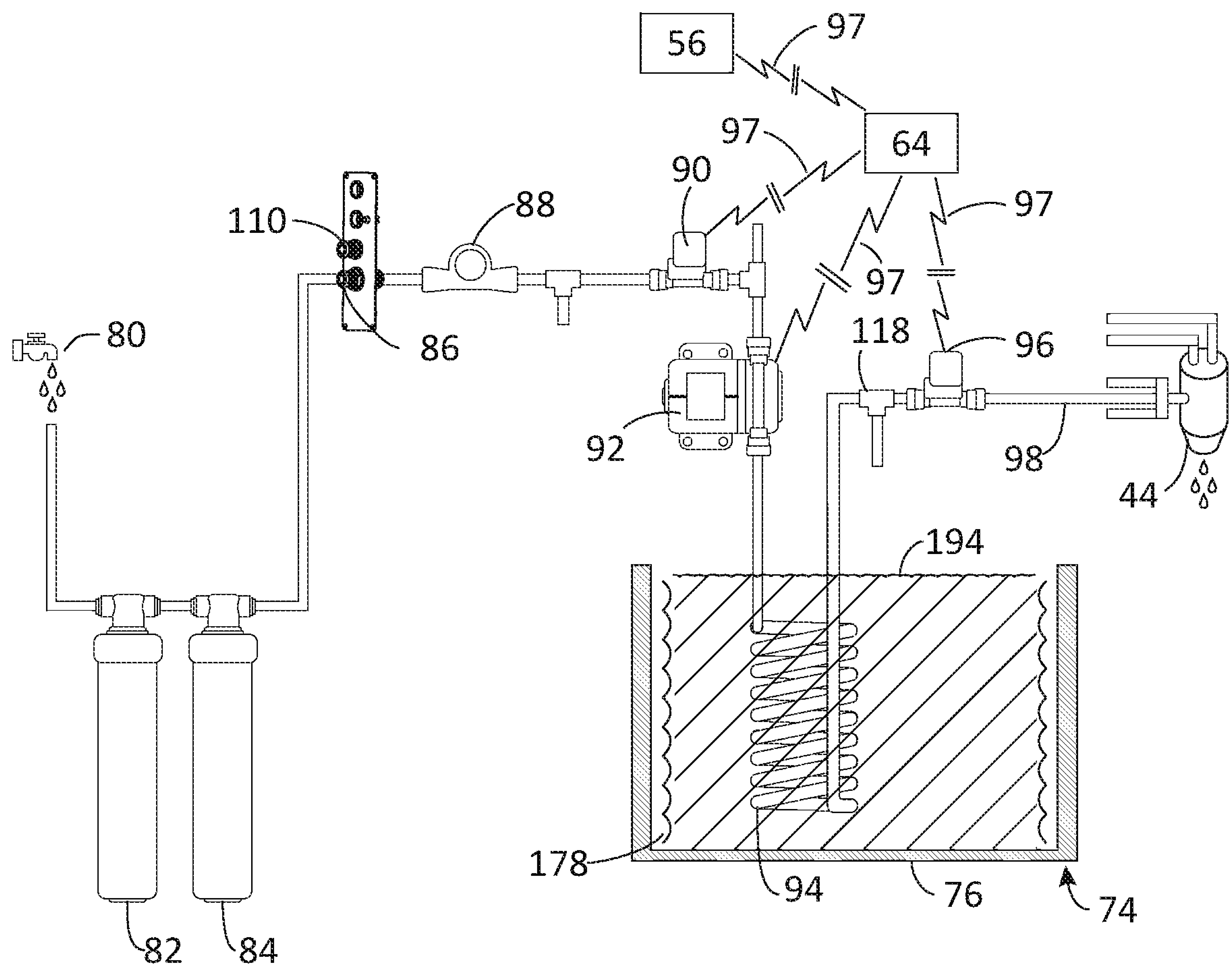
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FIG. 2C

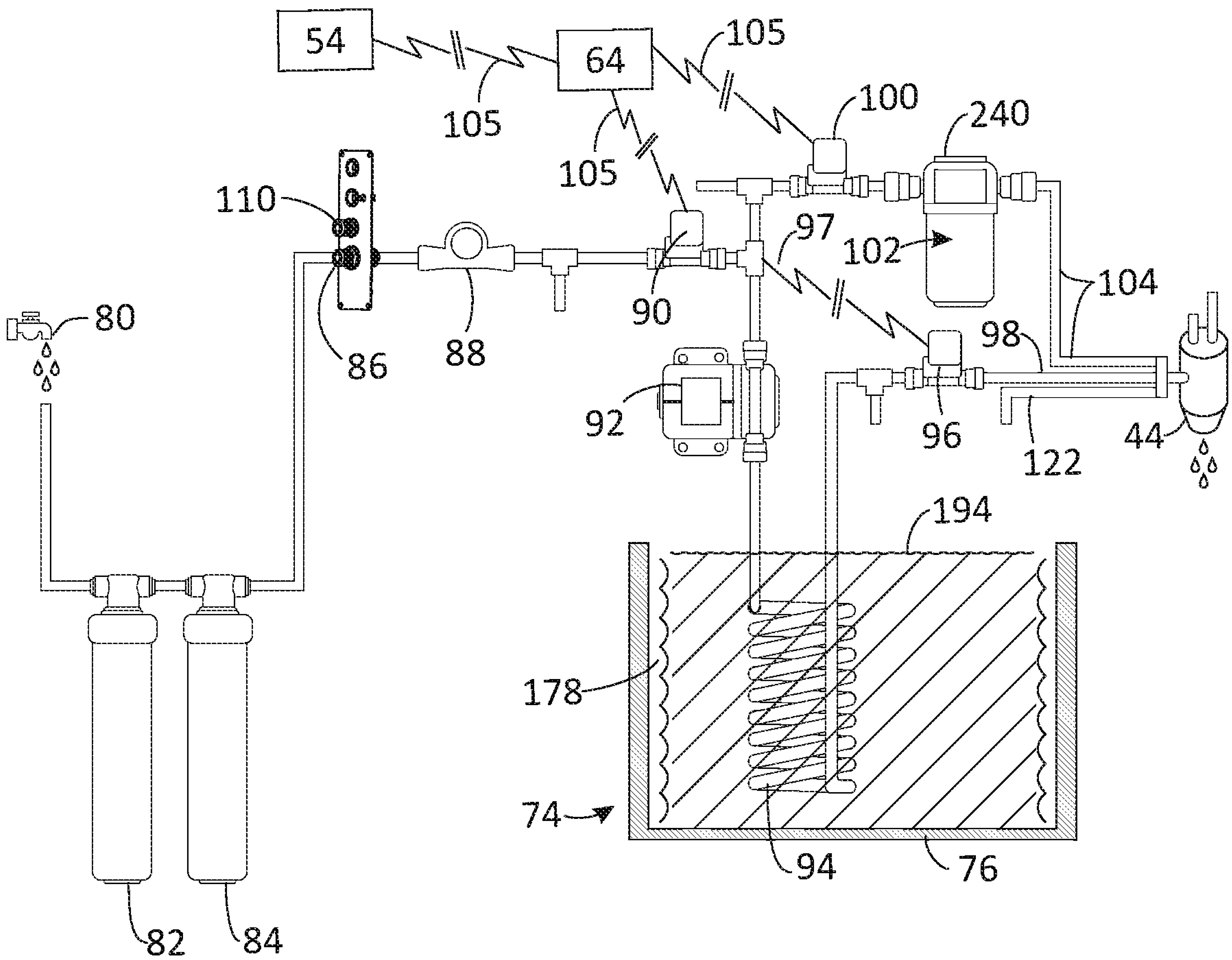
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FIG. 2D

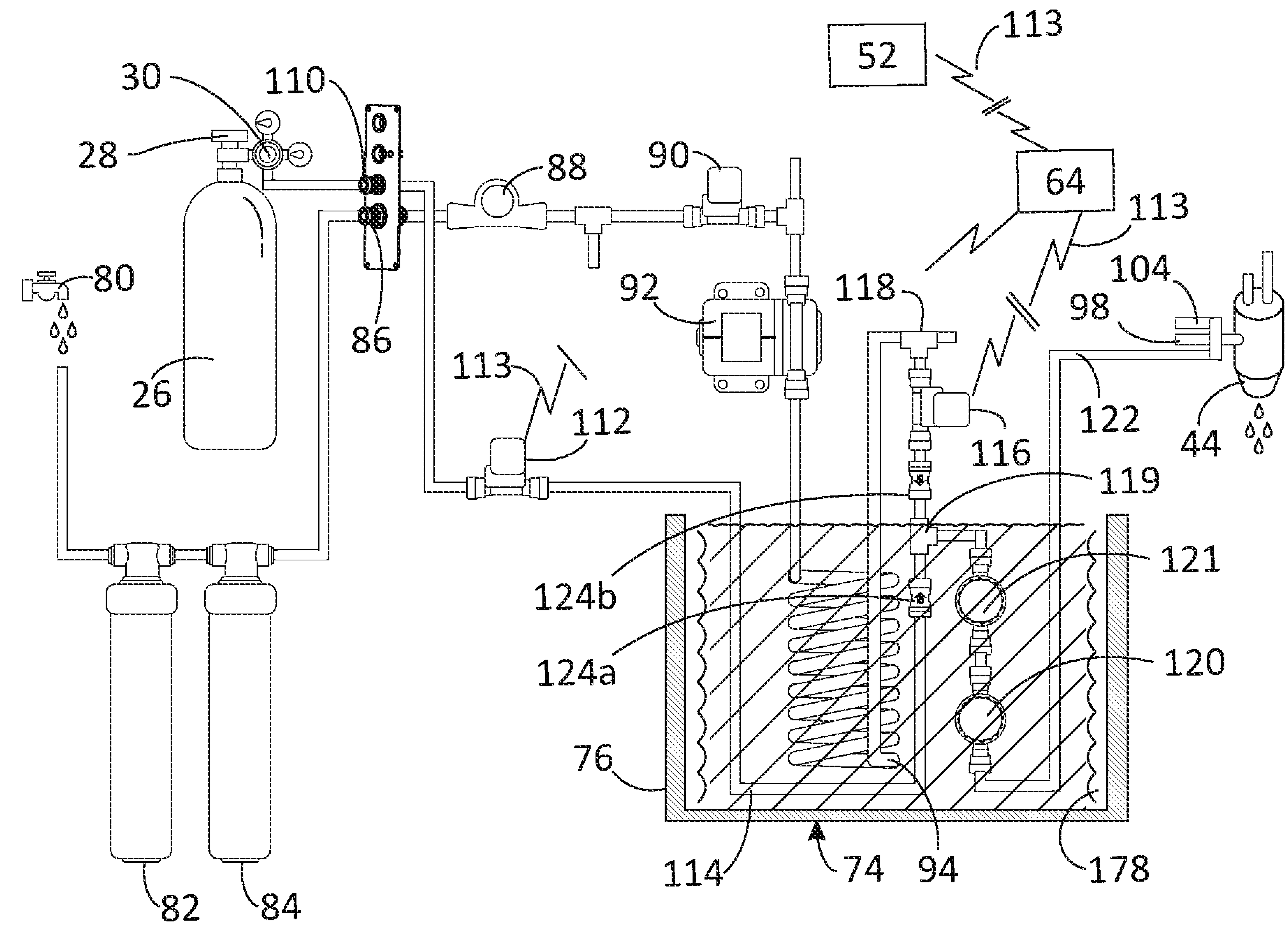
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FIG. 2E

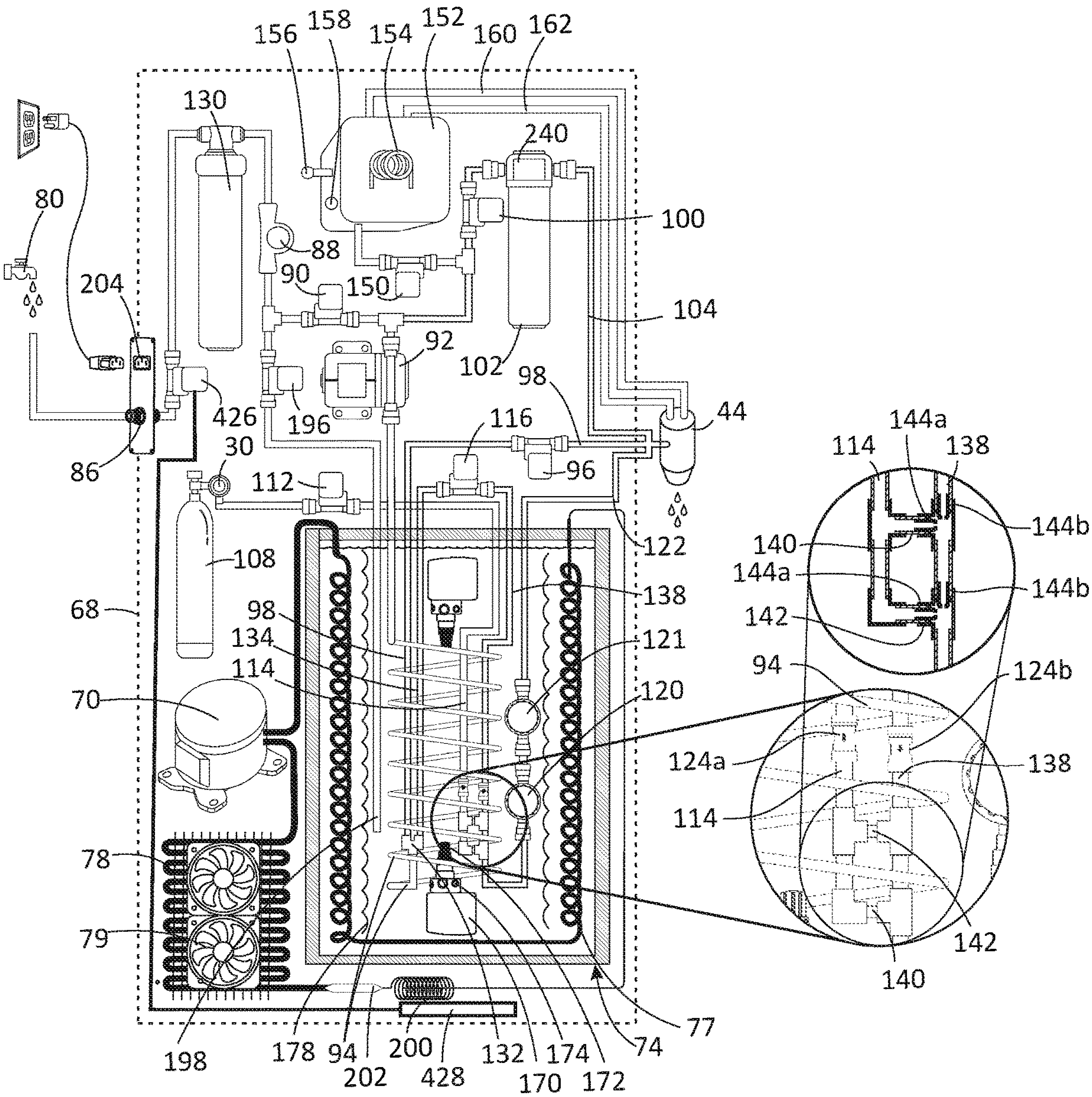
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FIG. 2F

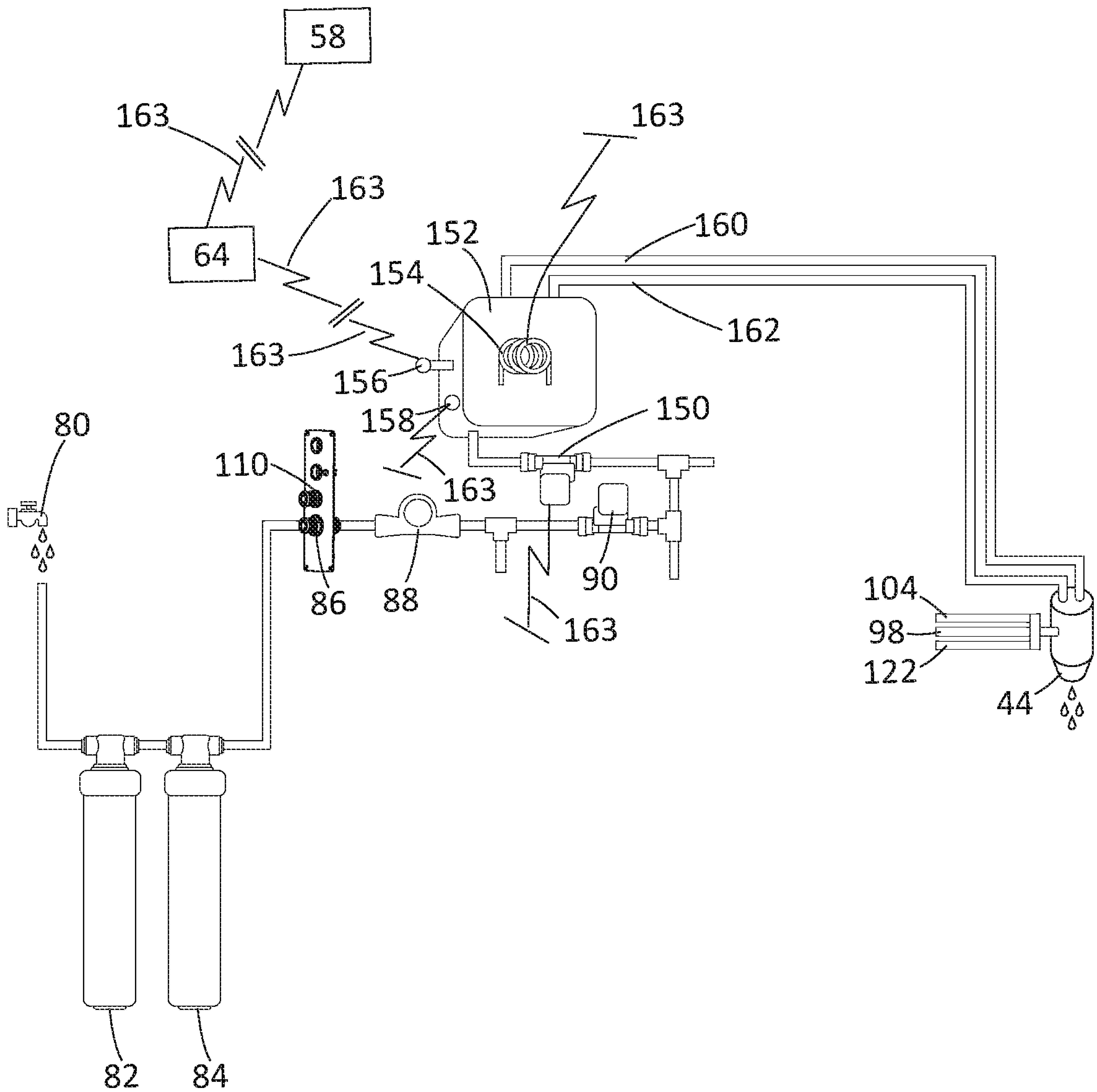
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FIG. 2G

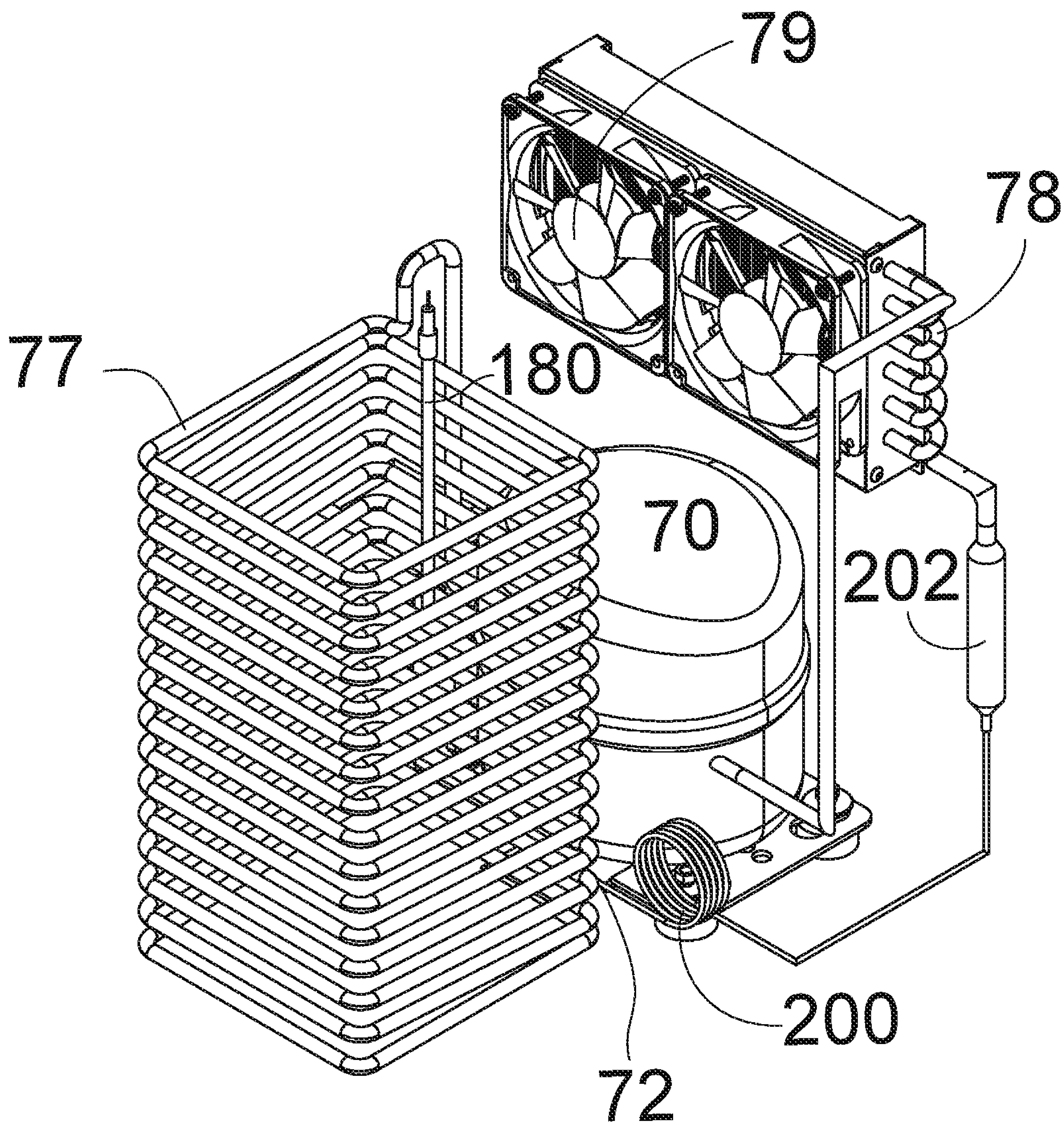

FIG. 3A

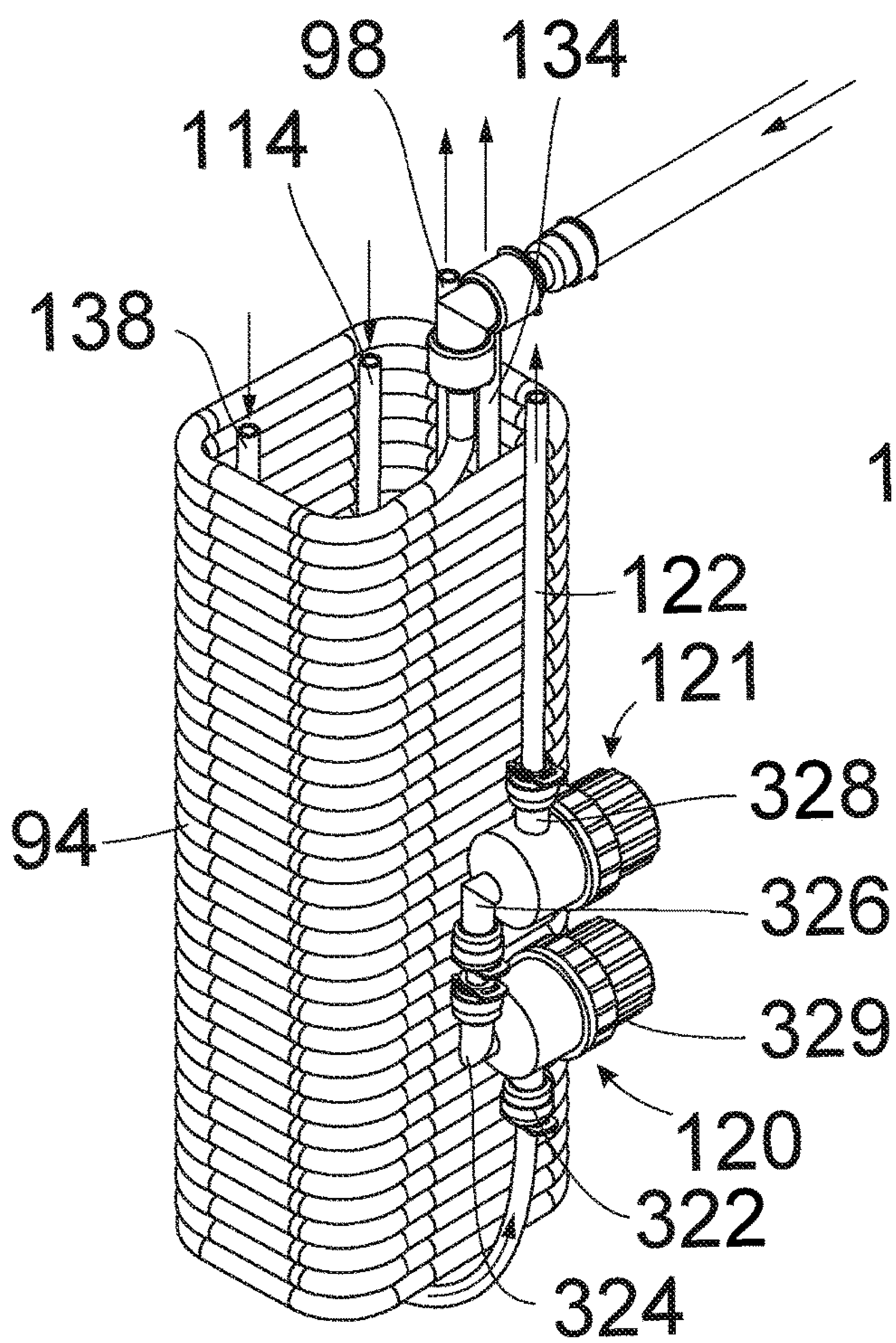
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FIG. 3B

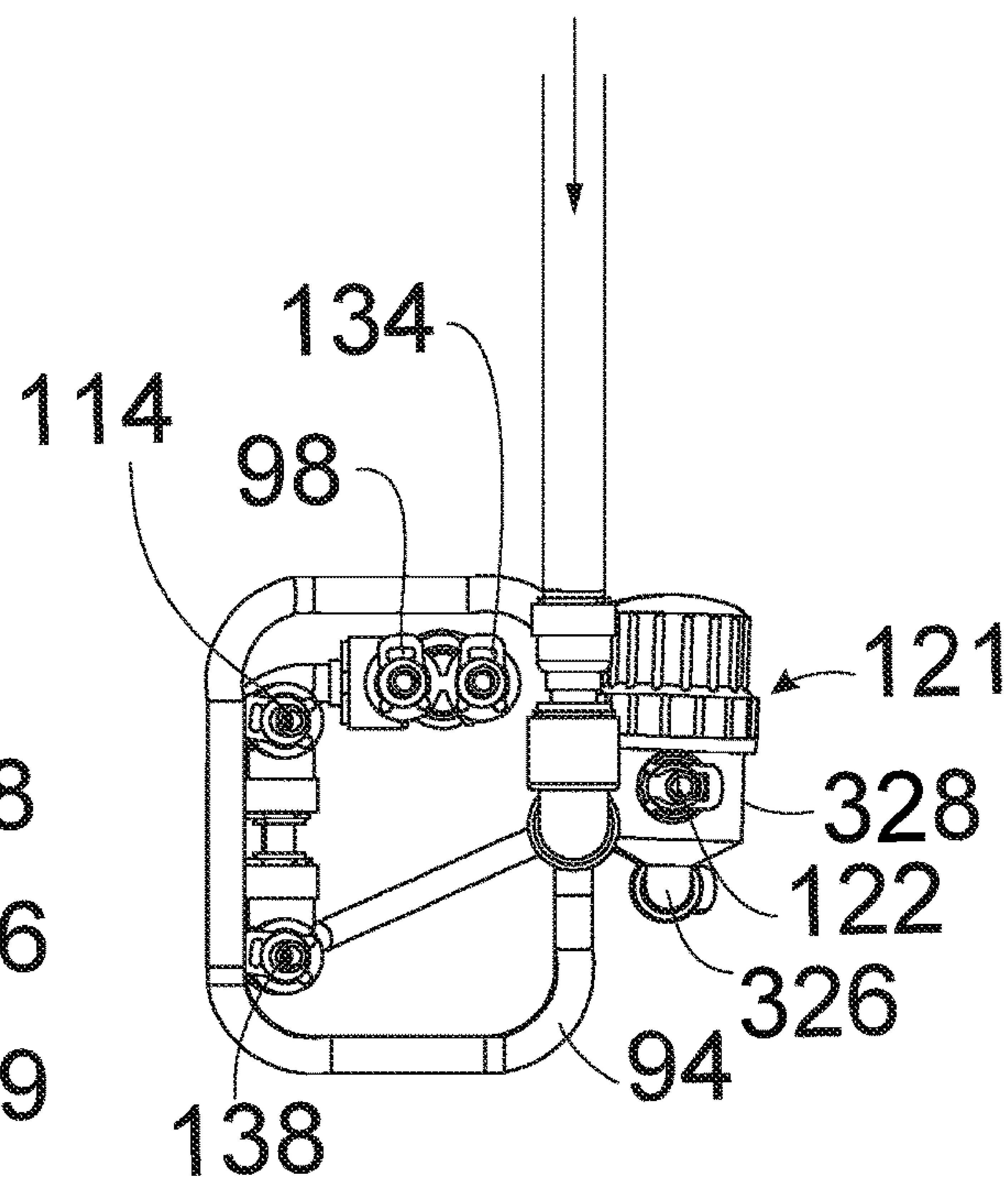
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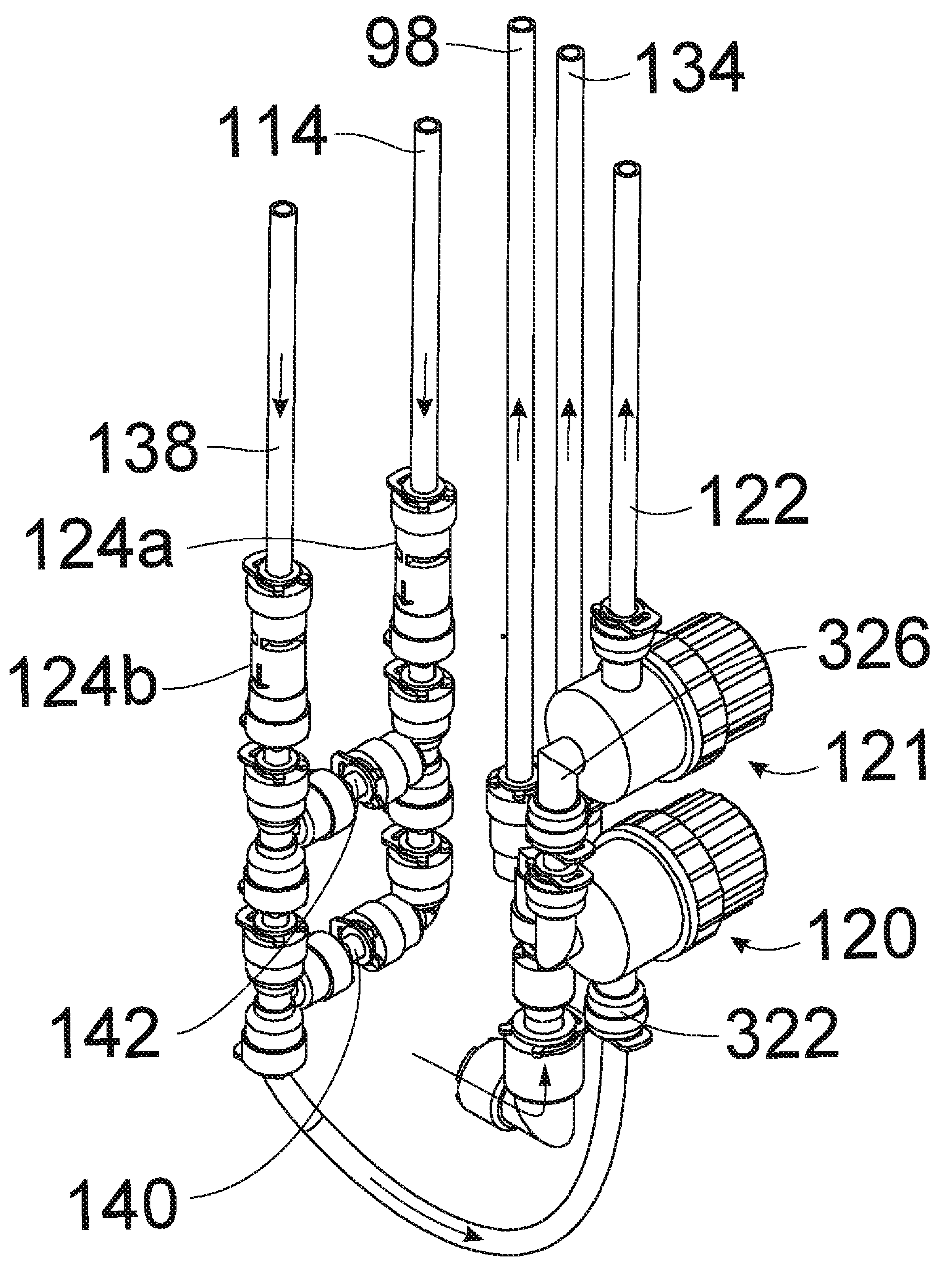
FIG. 3C



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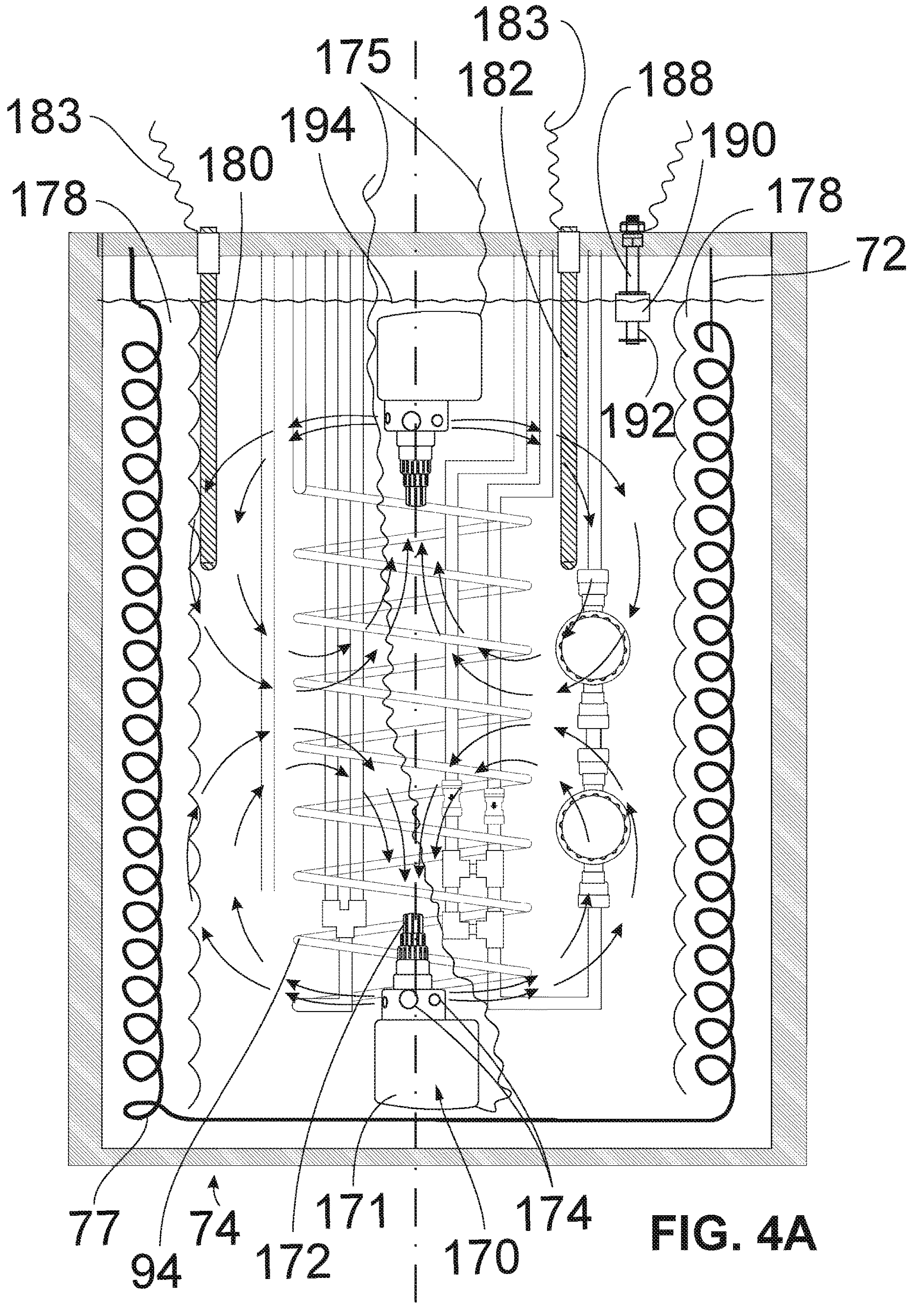
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FIG. 4A

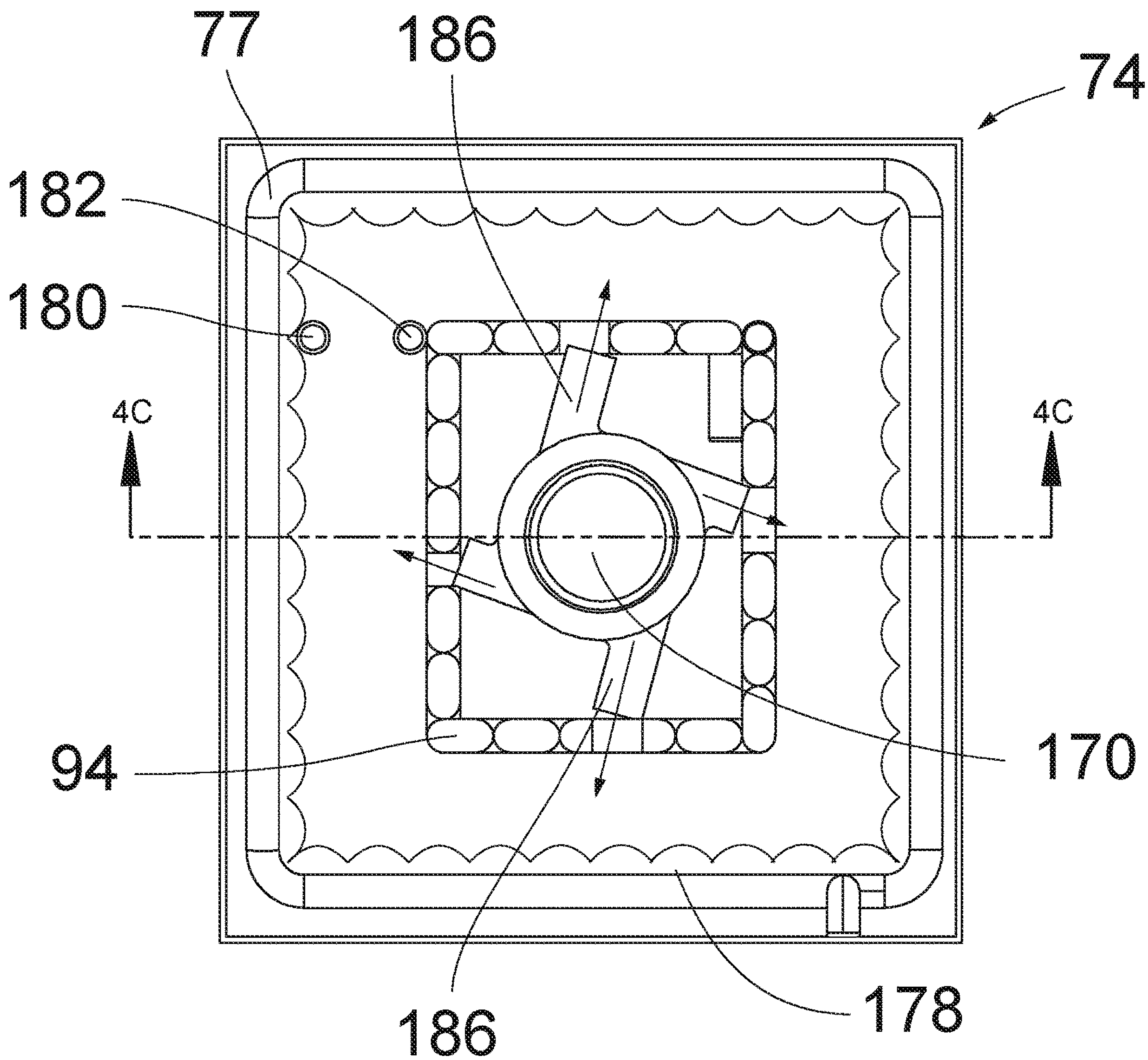

FIG. 4B

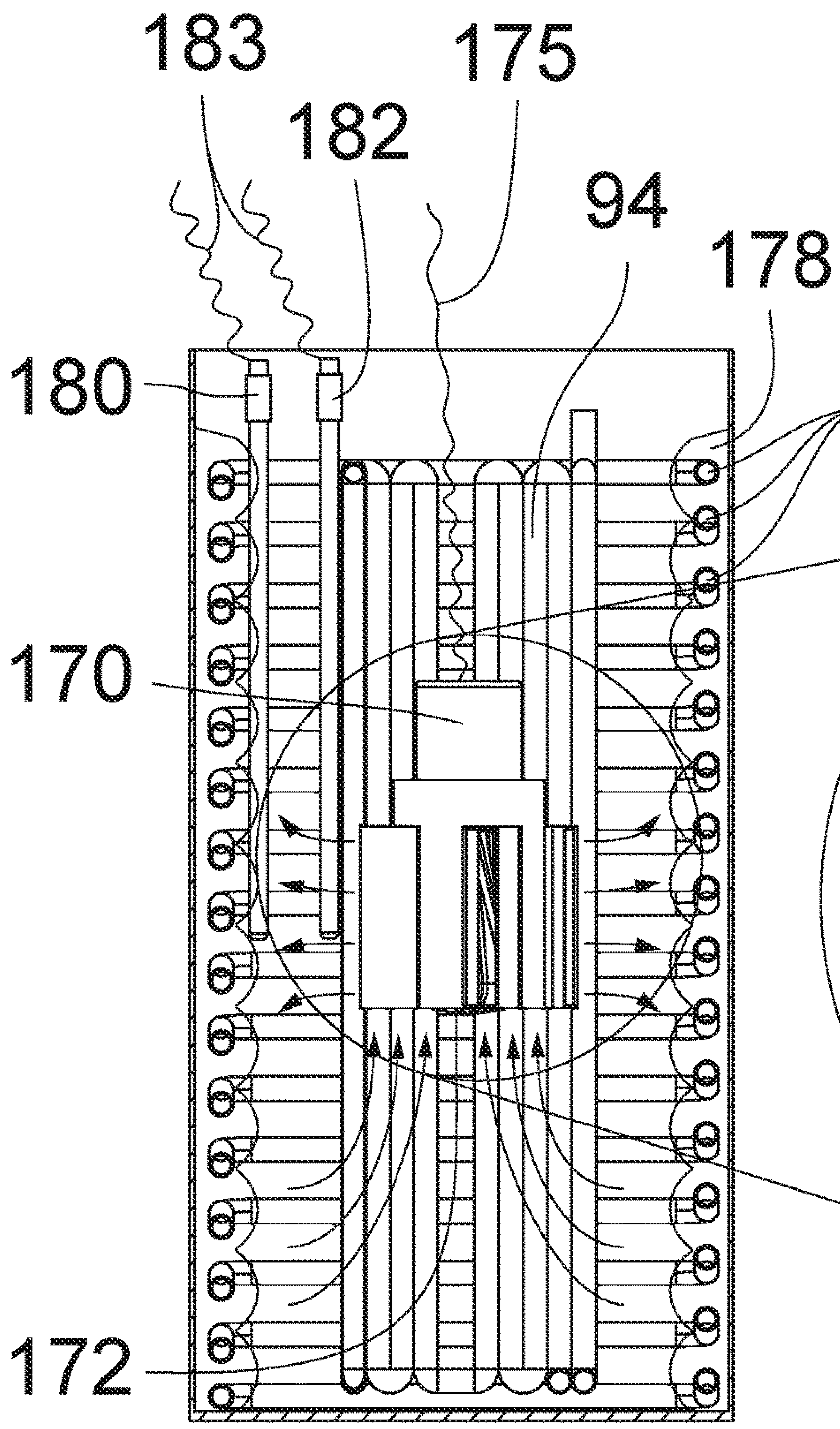

FIG. 4C

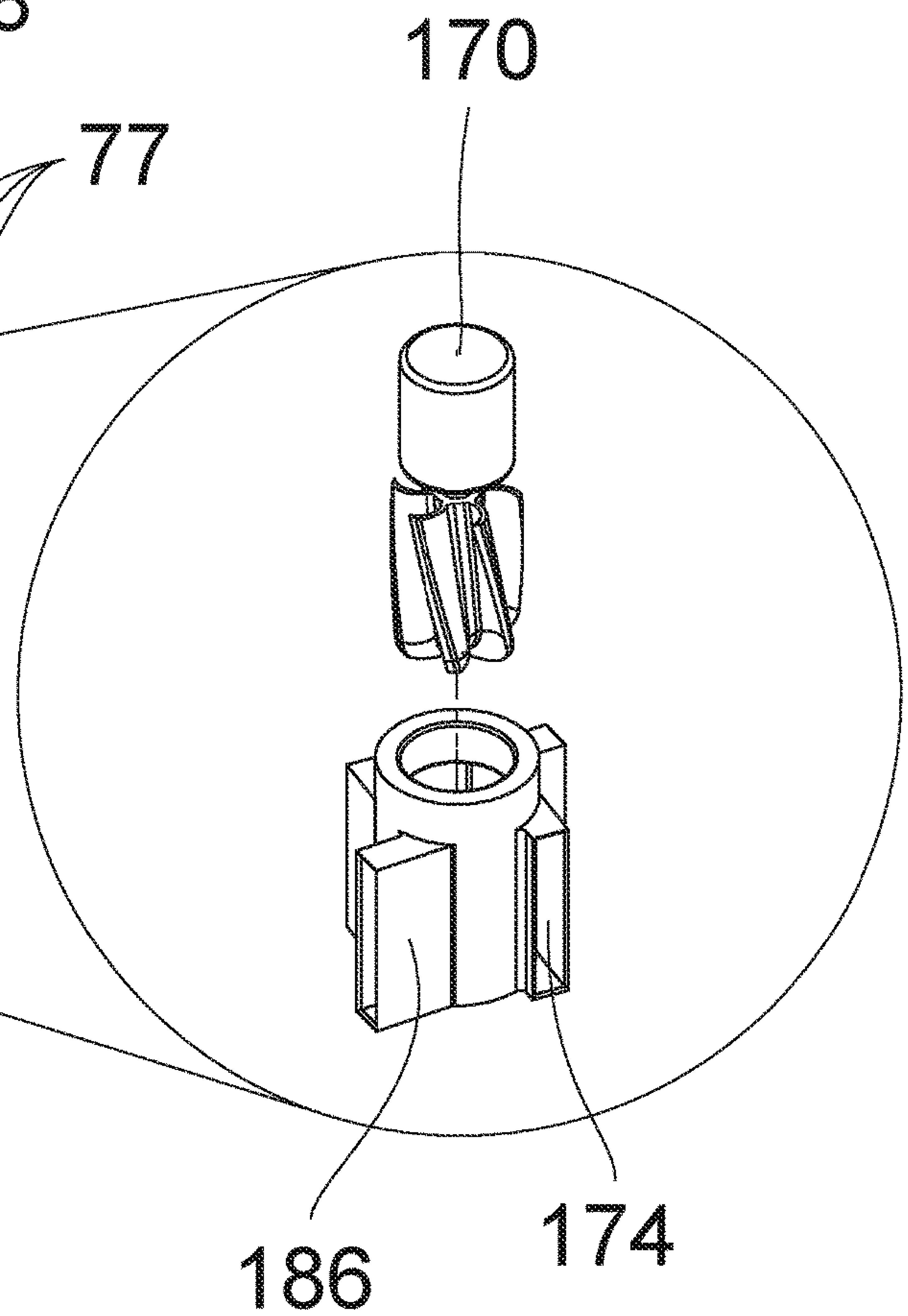

FIG. 4D

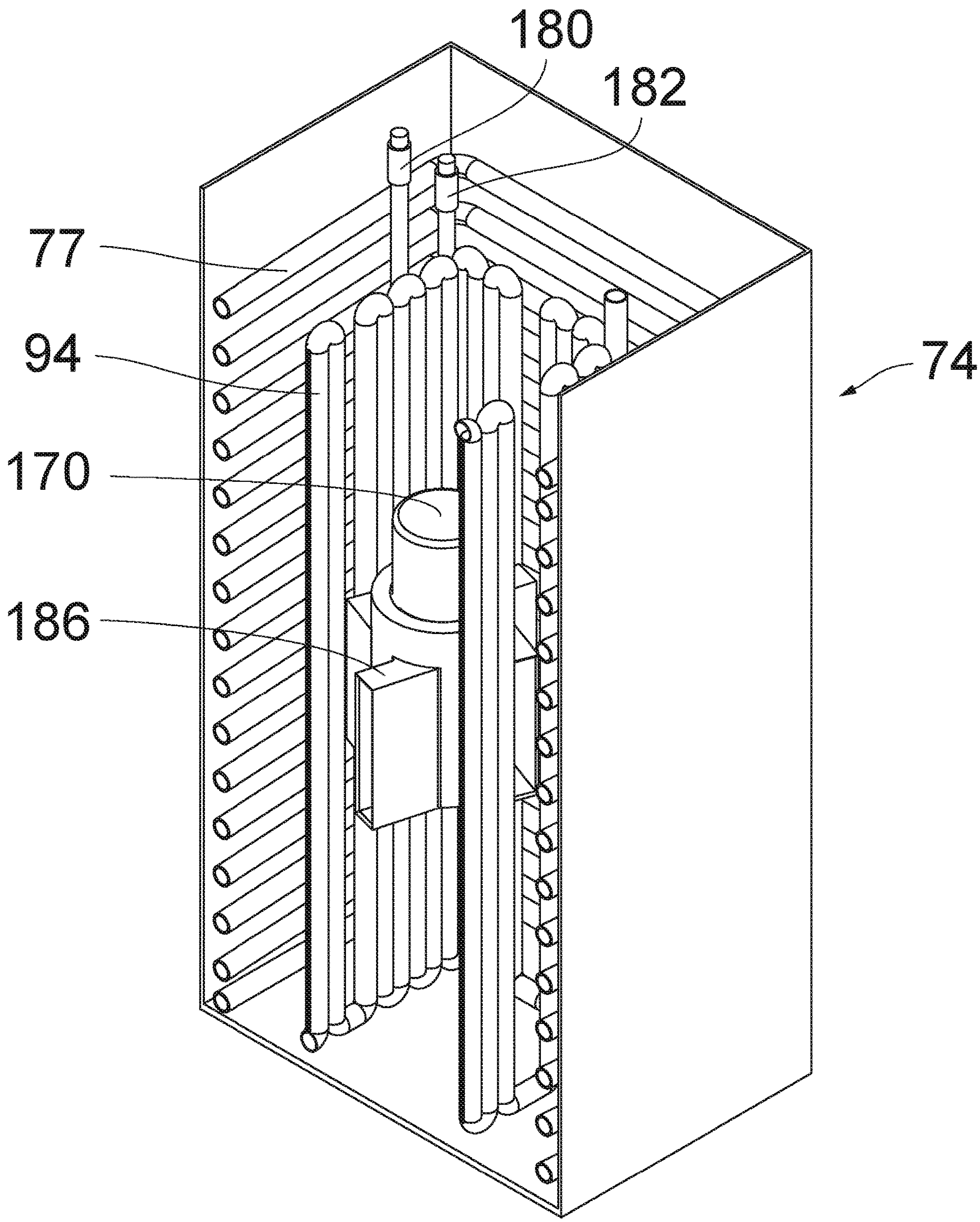

FIG. 4E

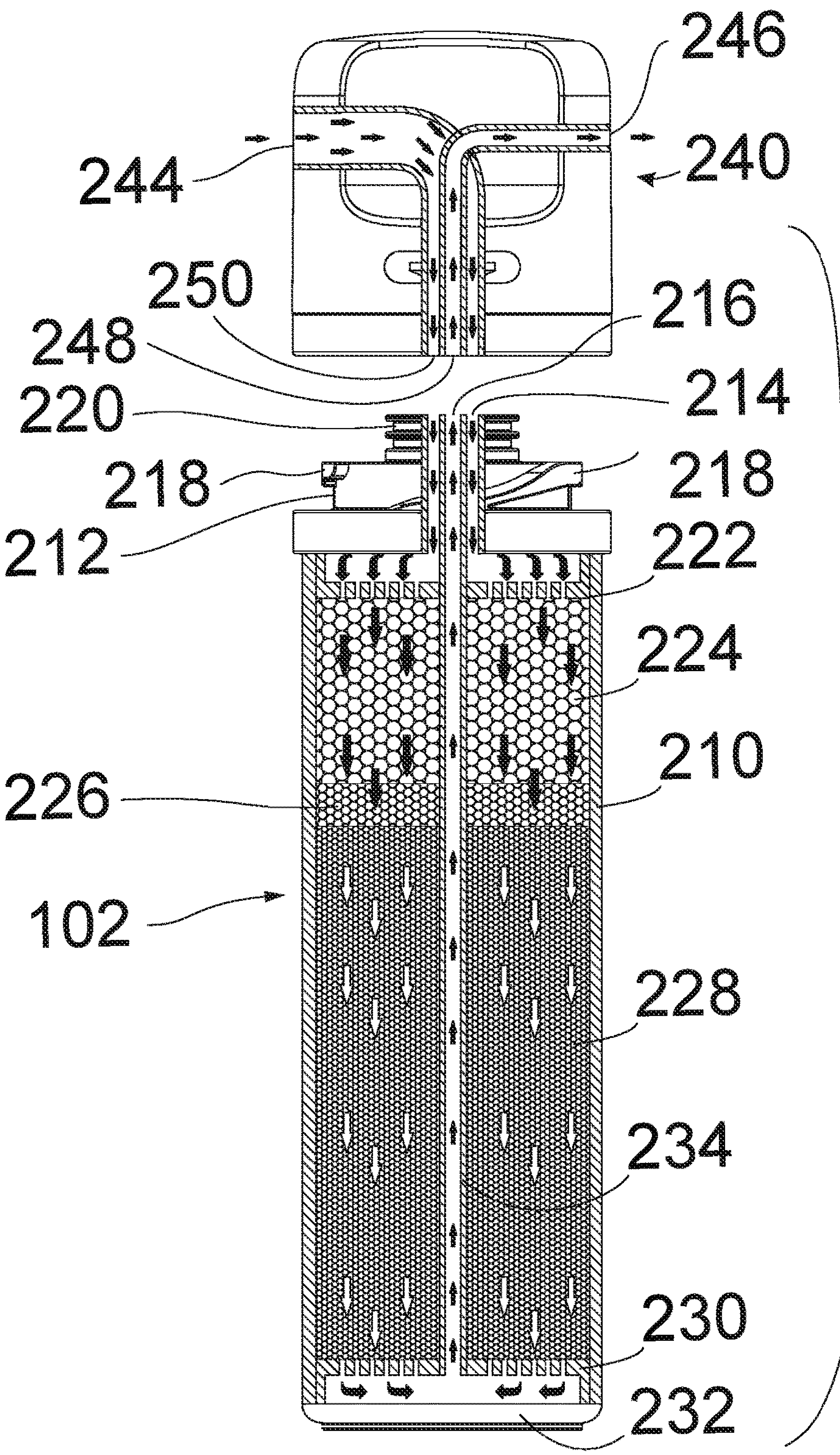
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FIG. 5

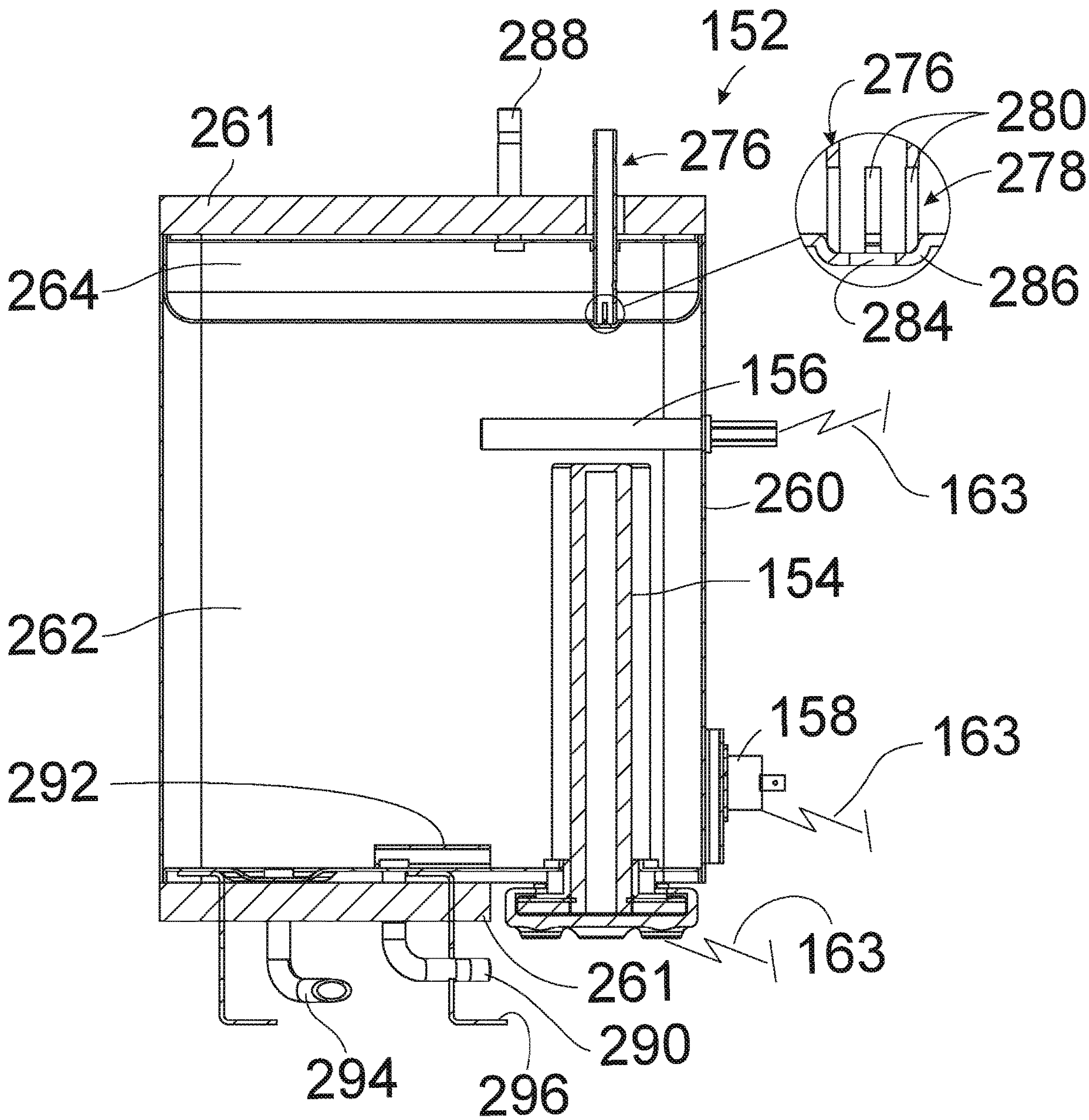
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FIG. 6A

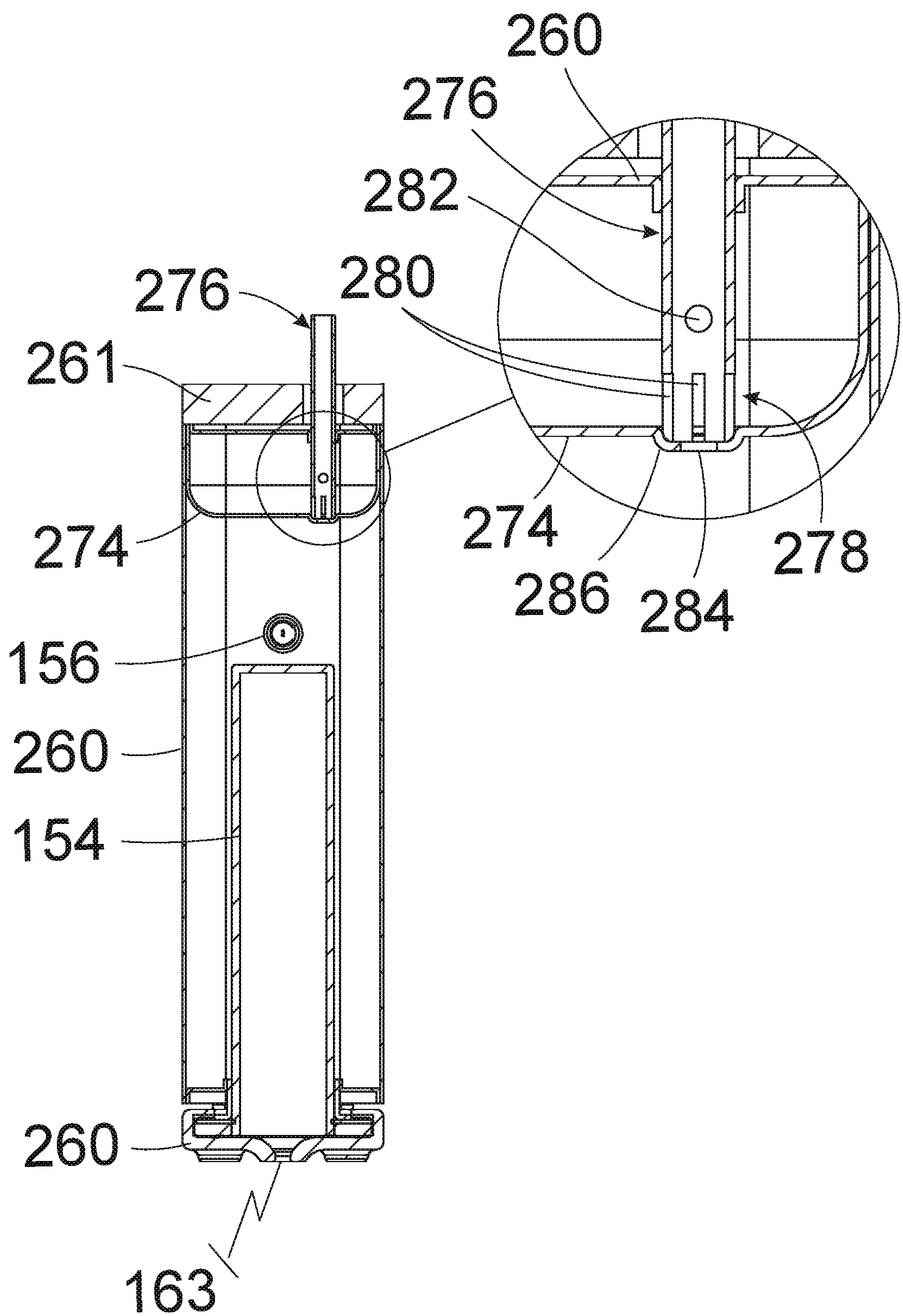


FIG. 6B

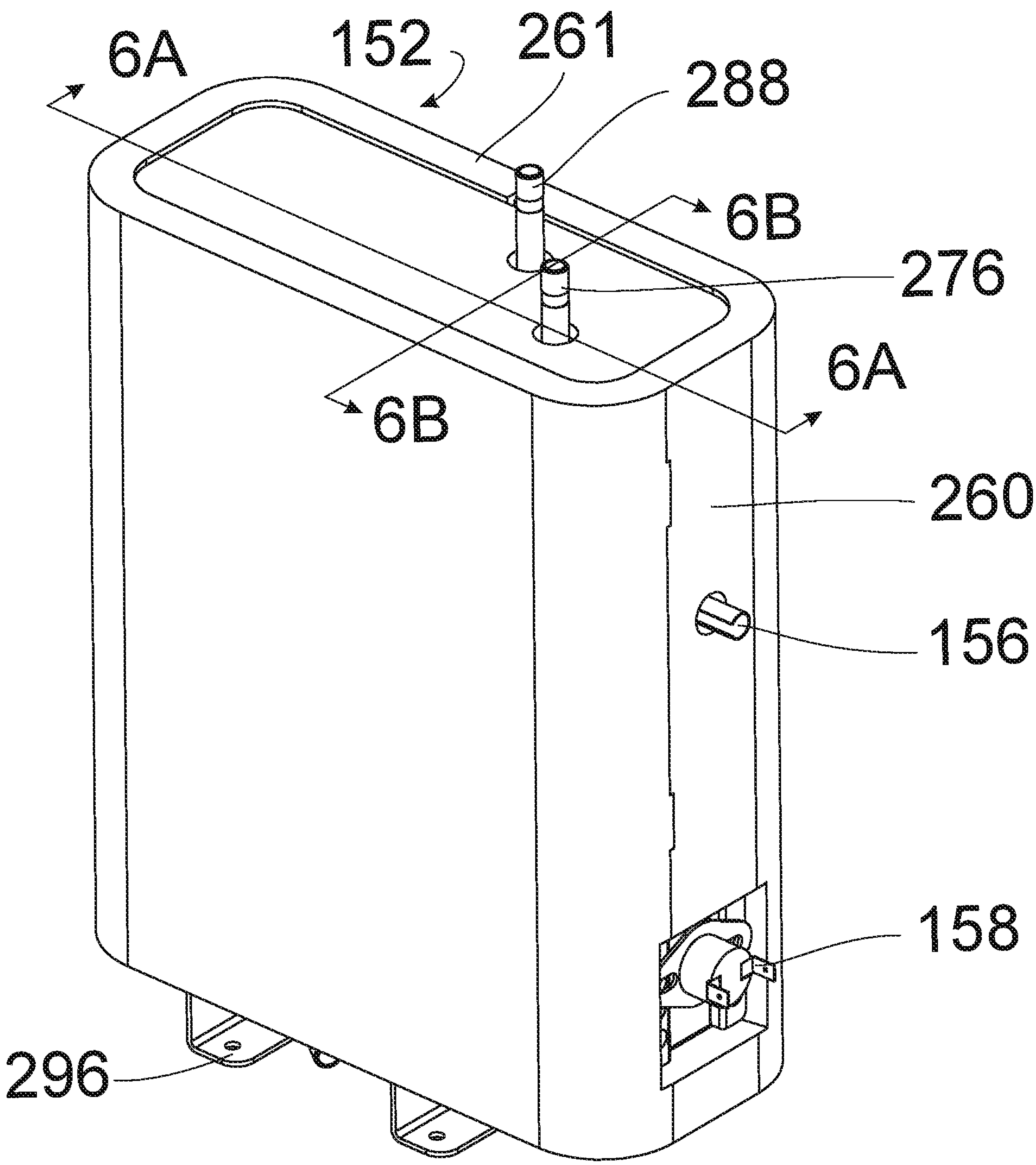


FIG. 6C

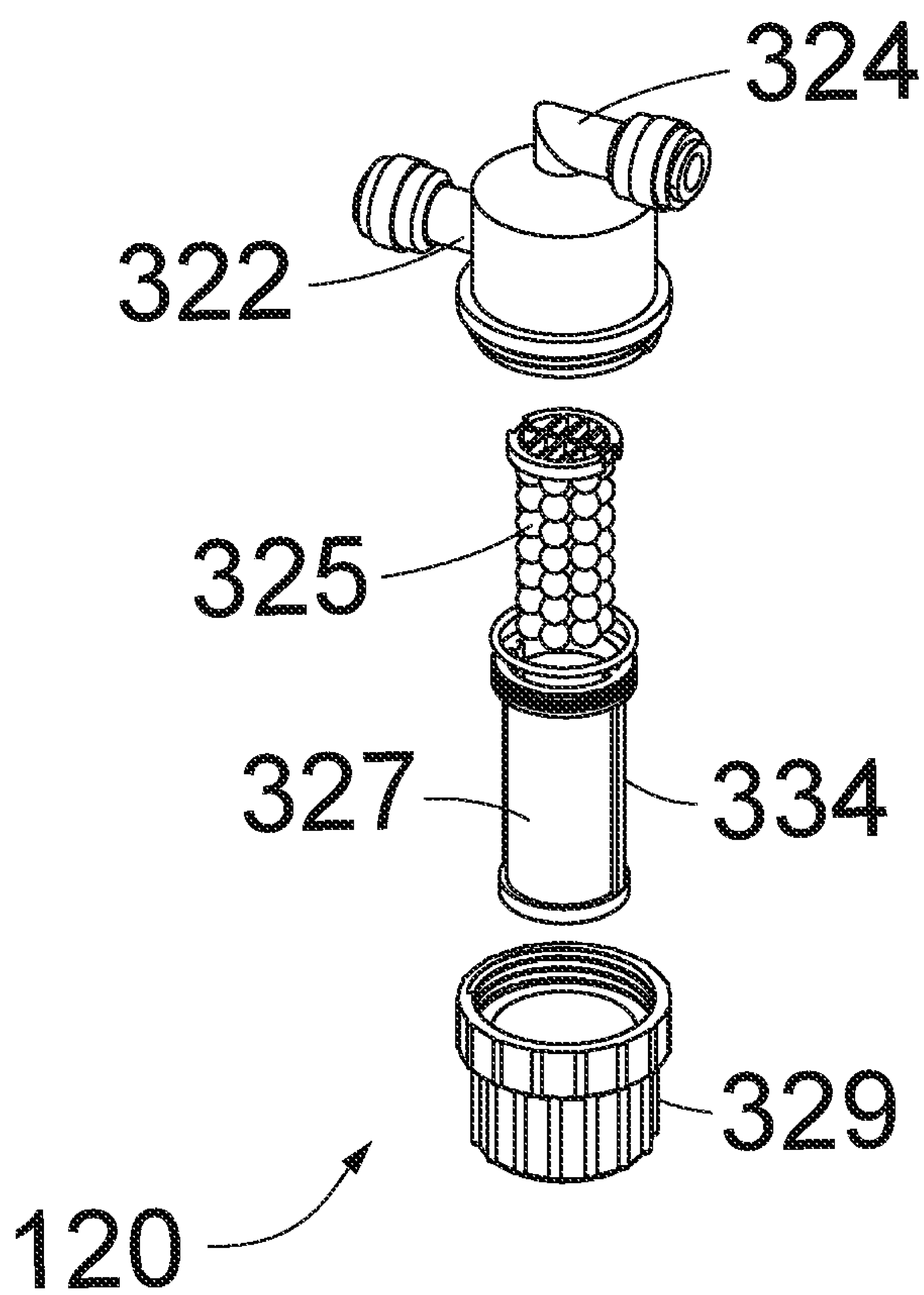


FIG. 7A

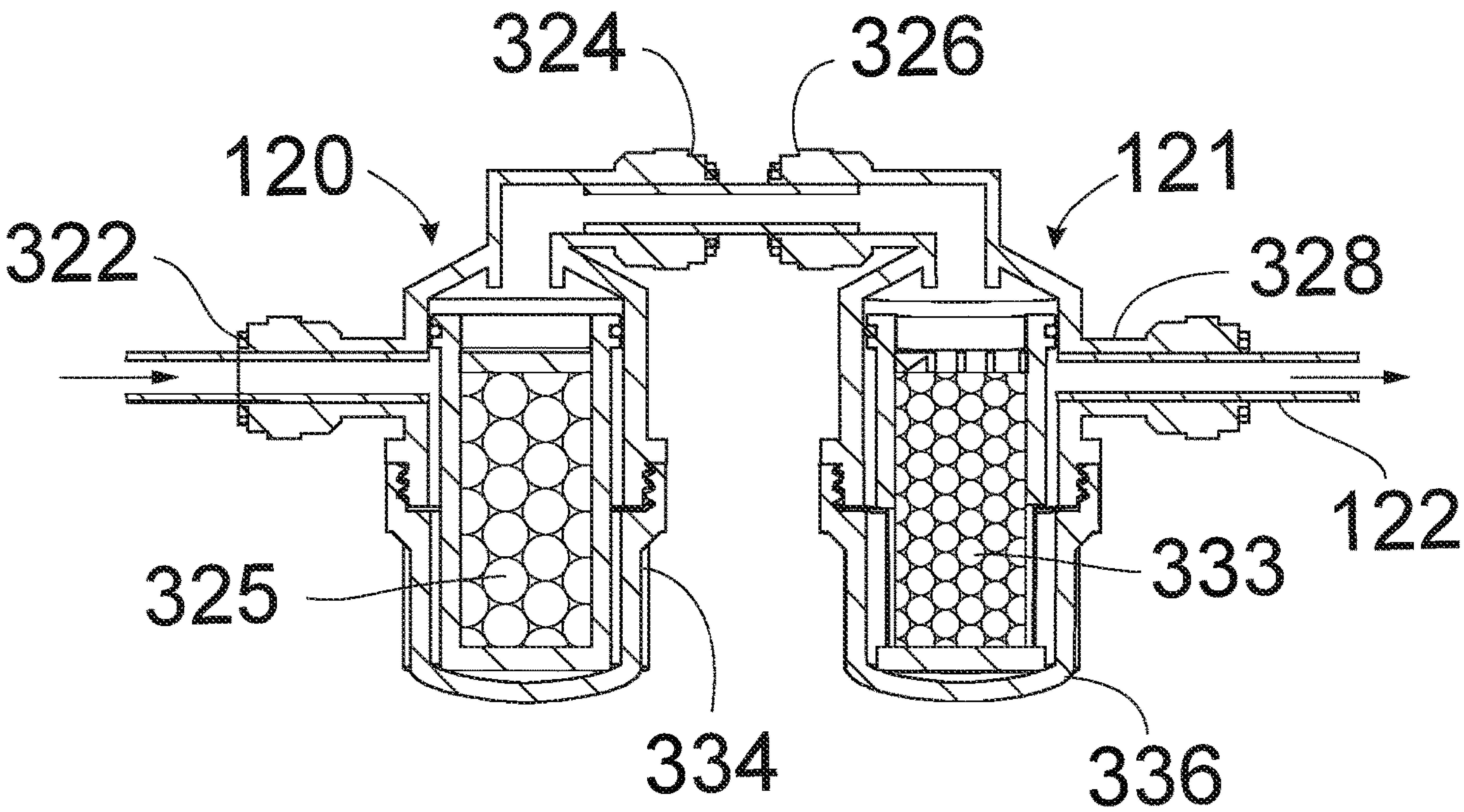


FIG. 7B

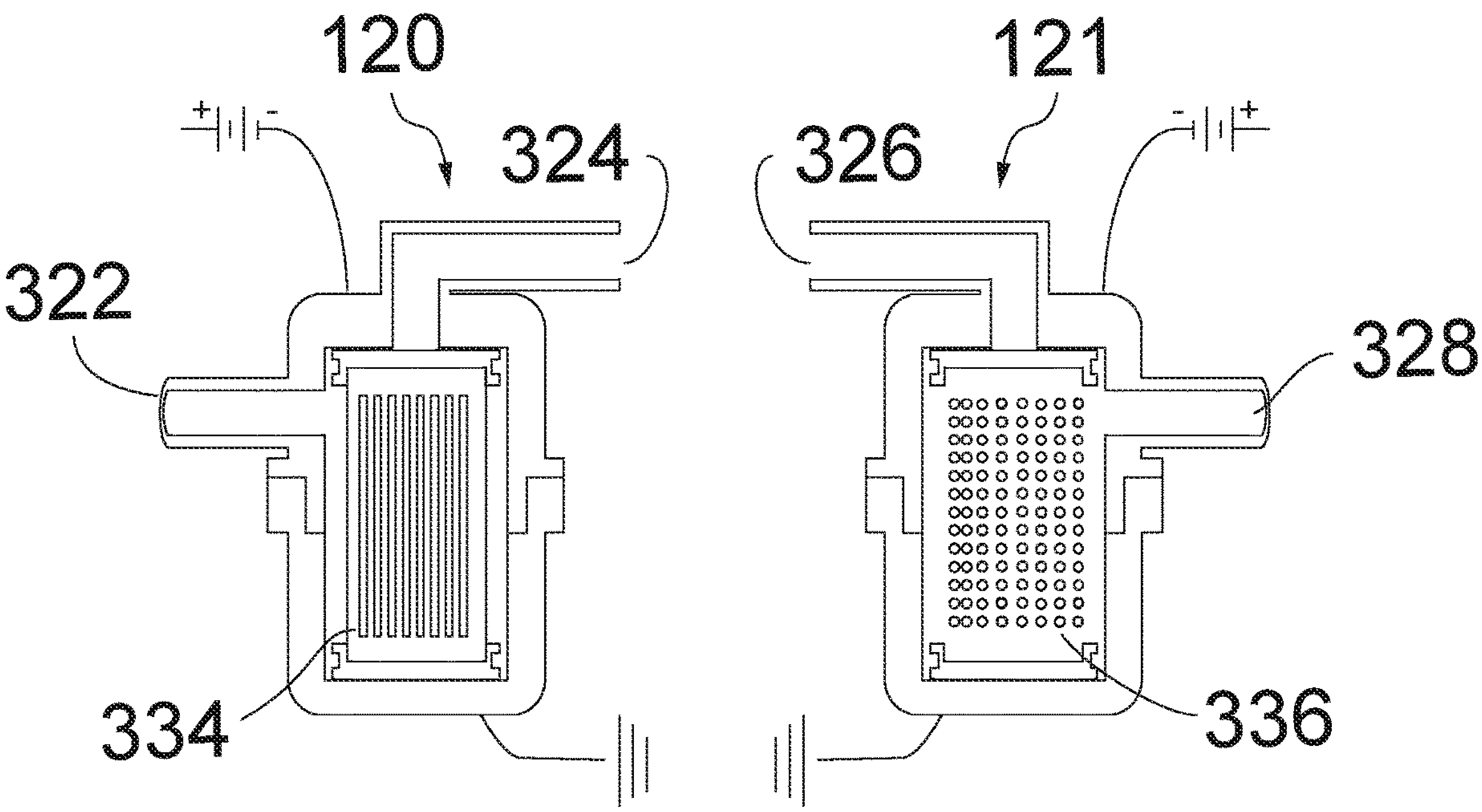
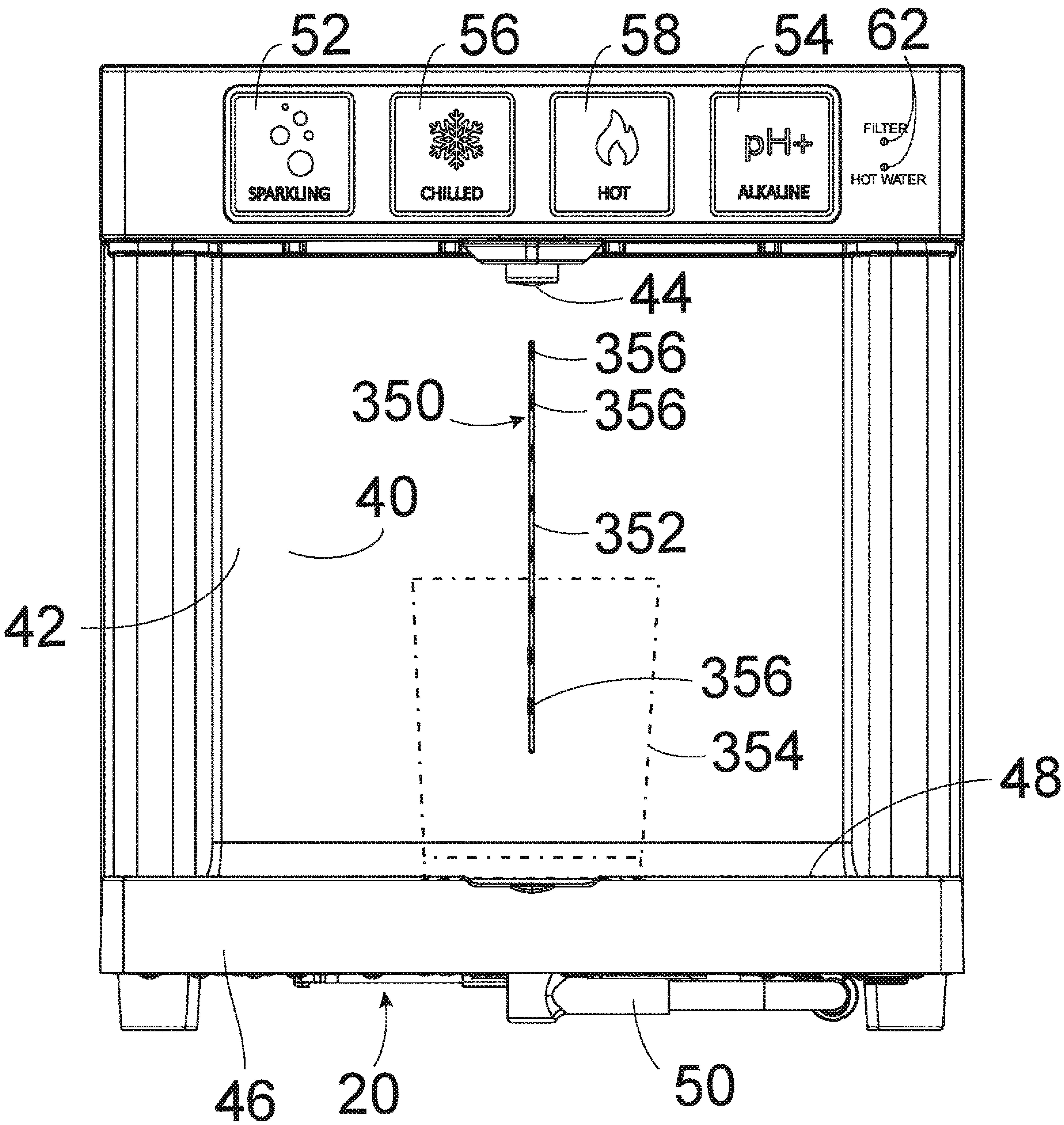


FIG. 7C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HOT WATER
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FIG. 8A

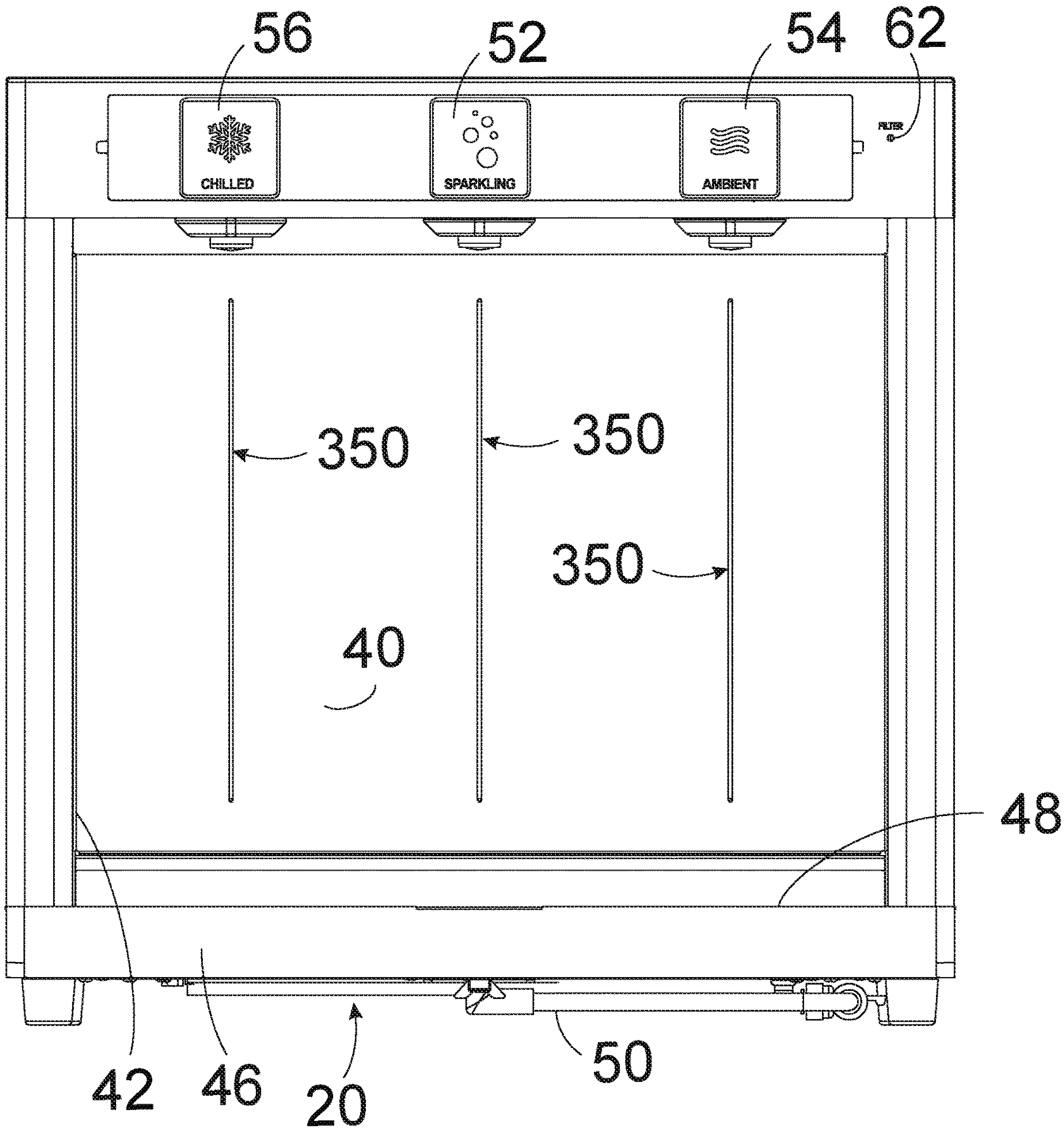
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FIG. 8B

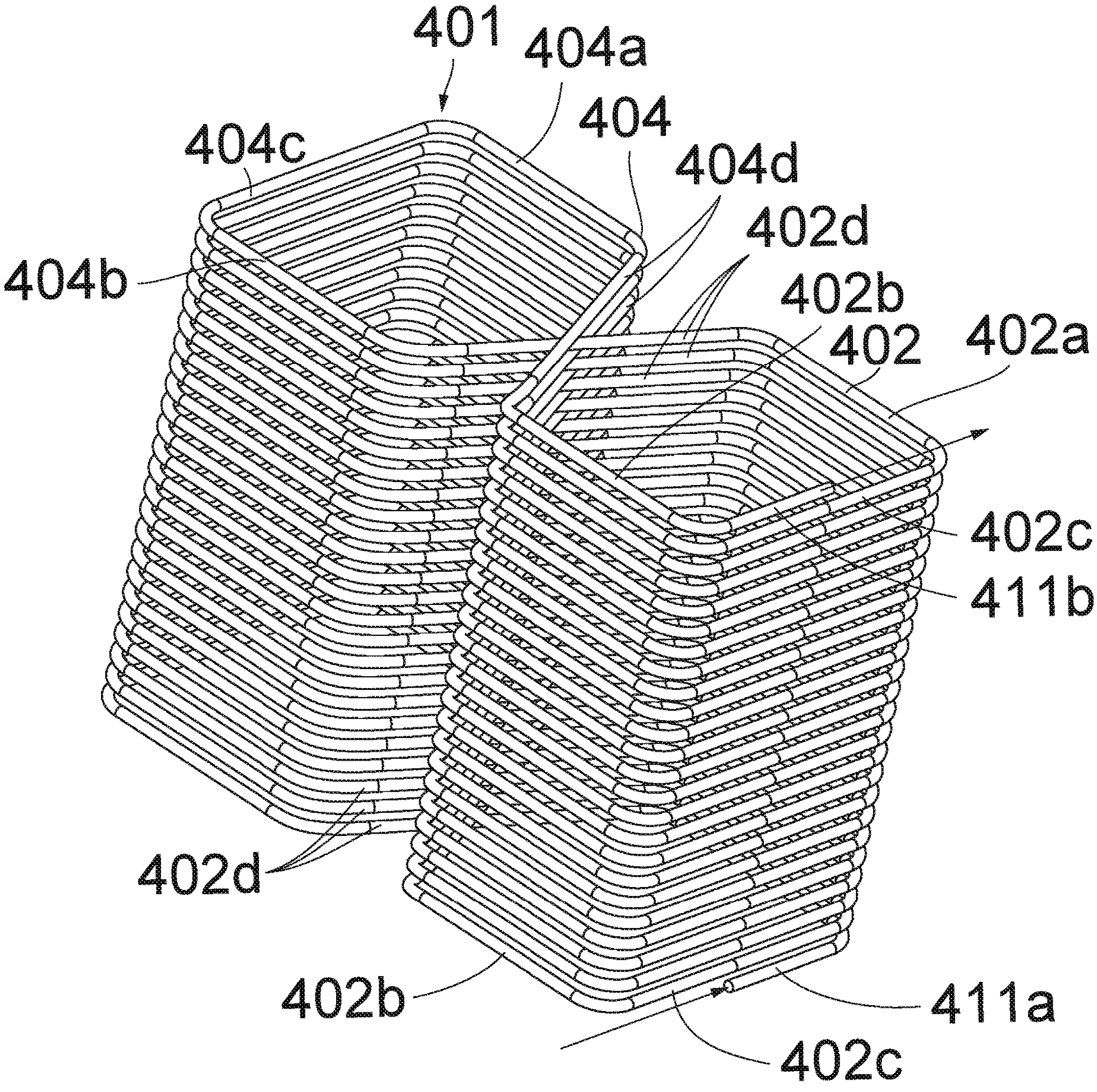
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FIG. 9A

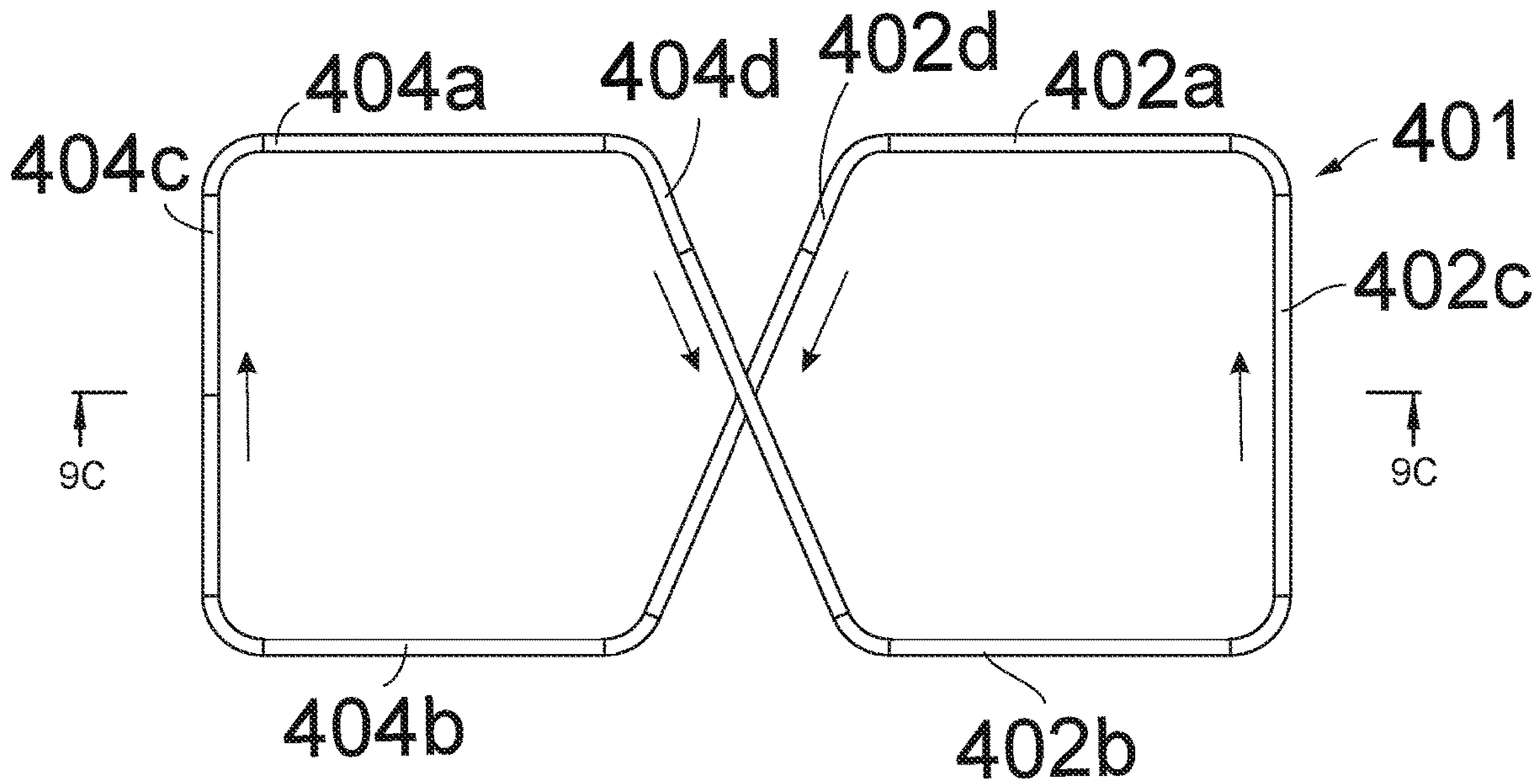
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FIG. 9B

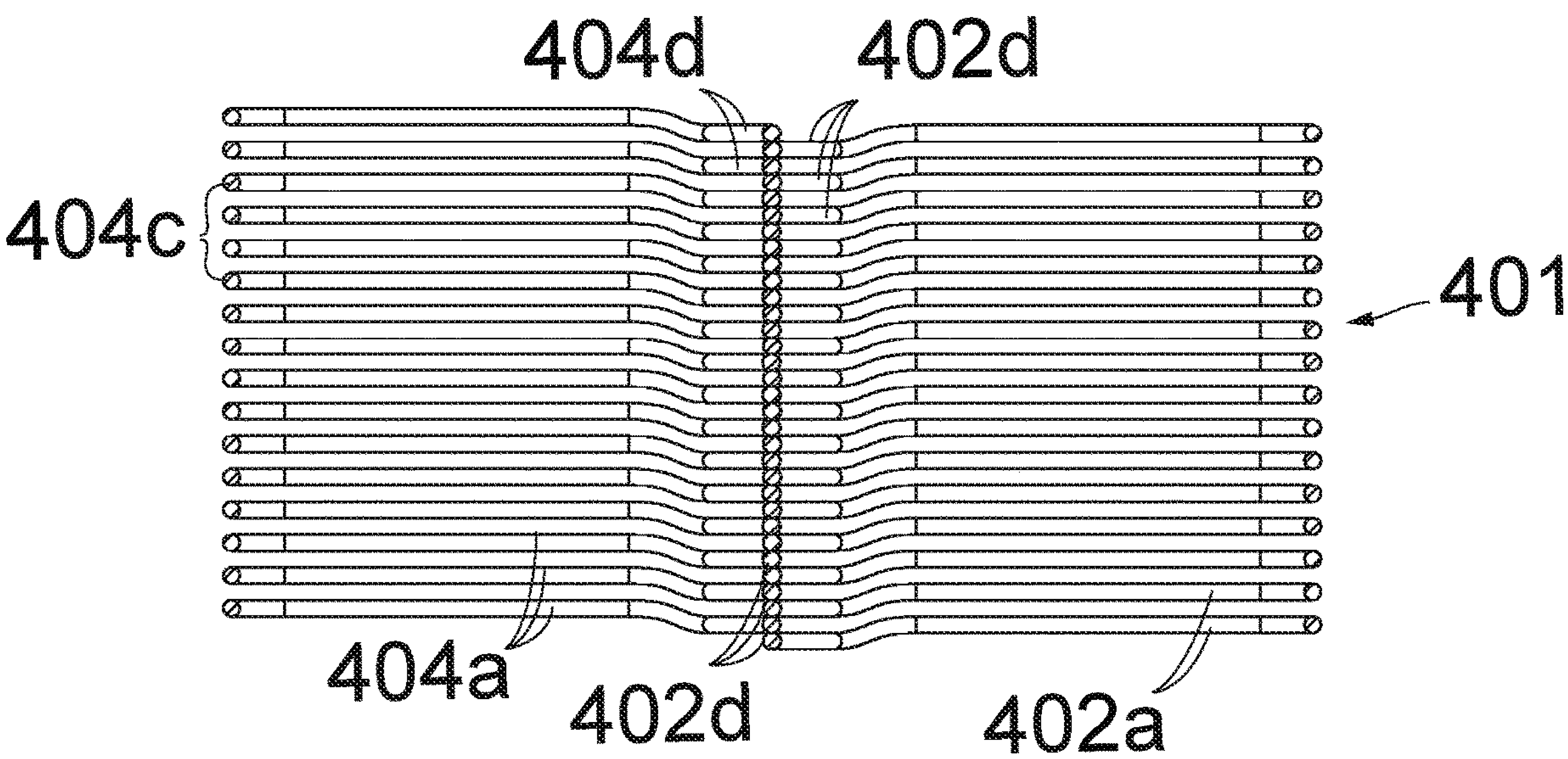
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FIG. 9C

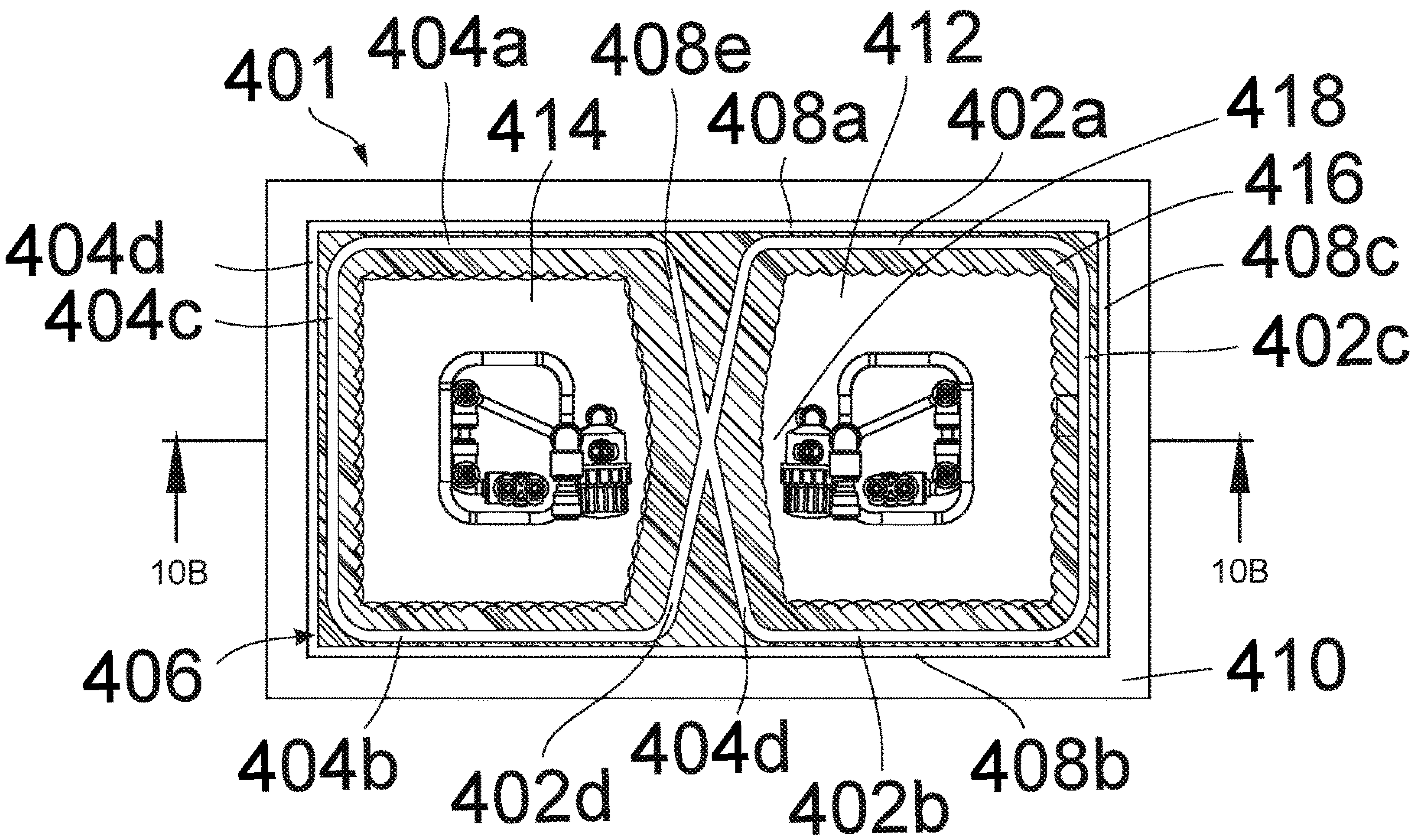

FIG. 10A

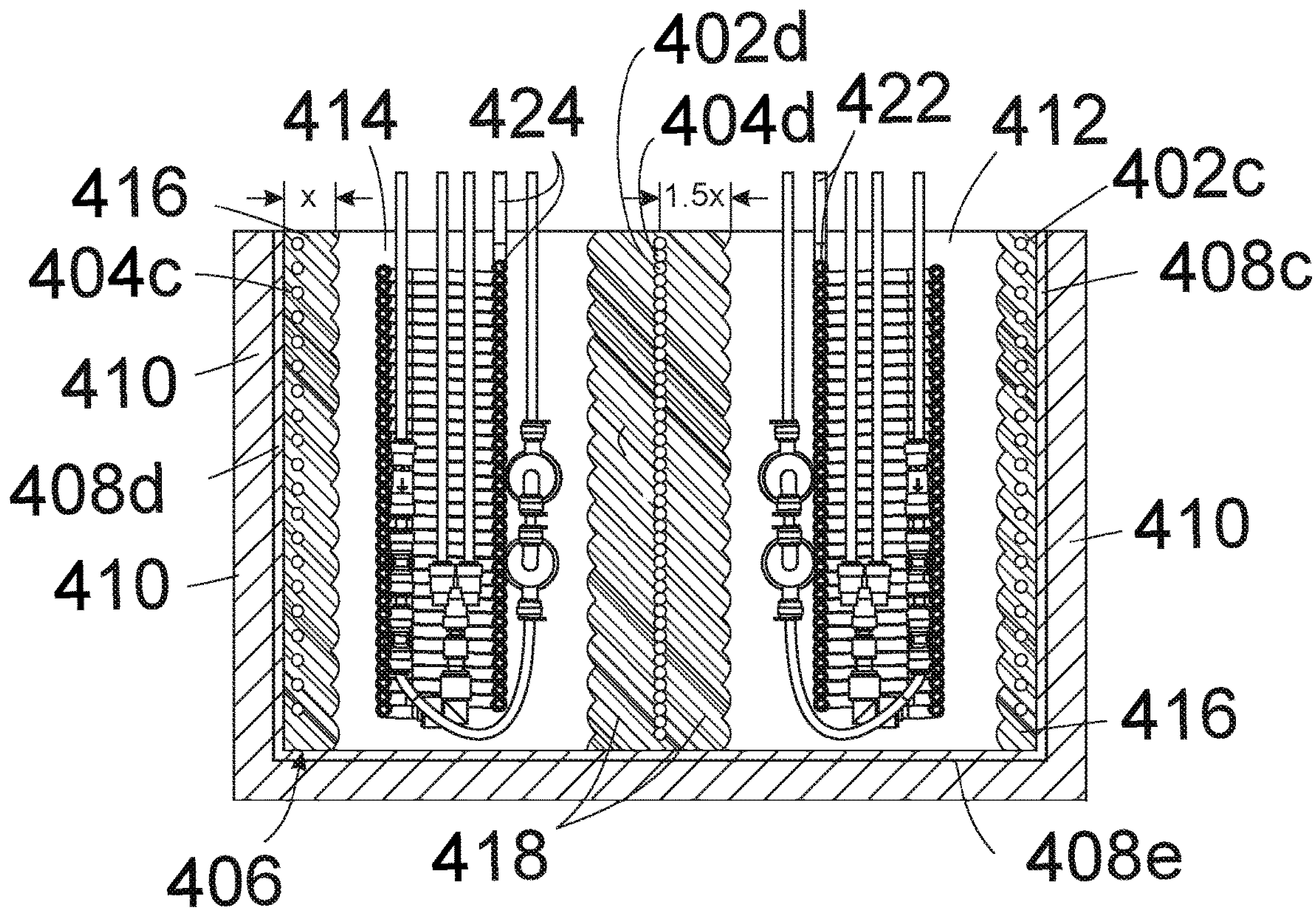

FIG. 10B

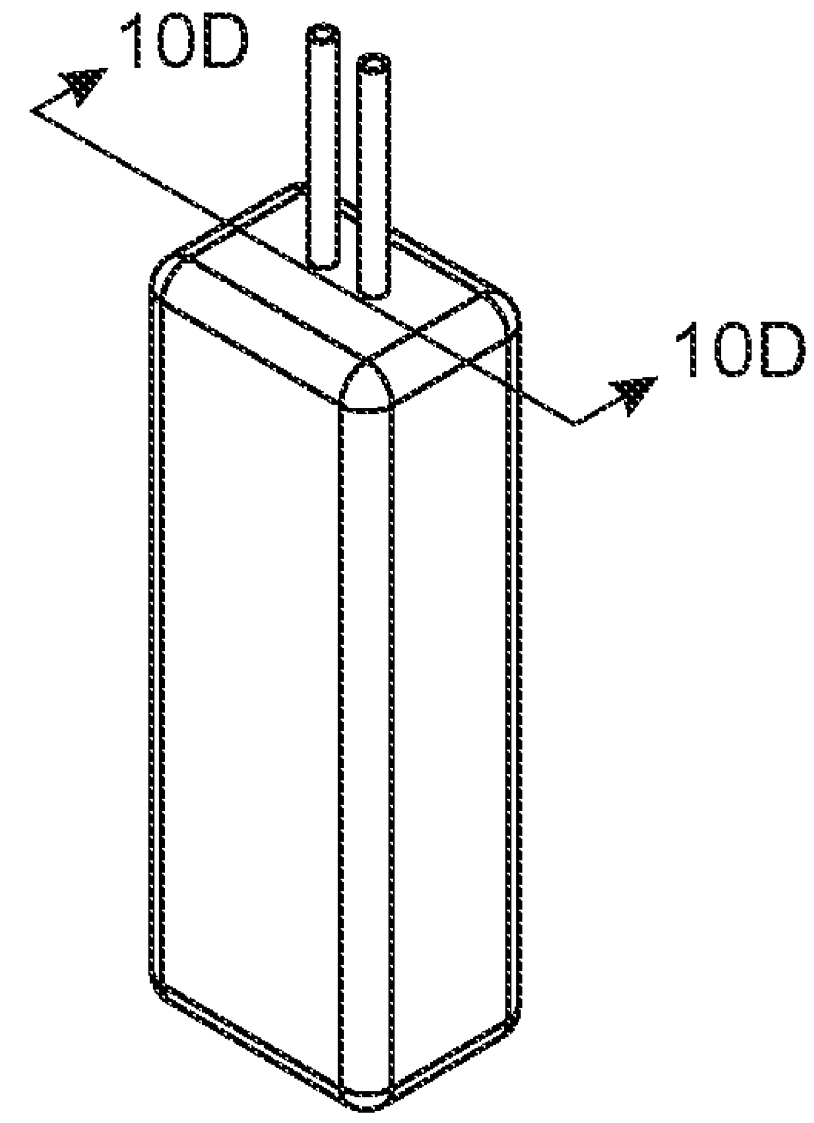

FIG. 10C

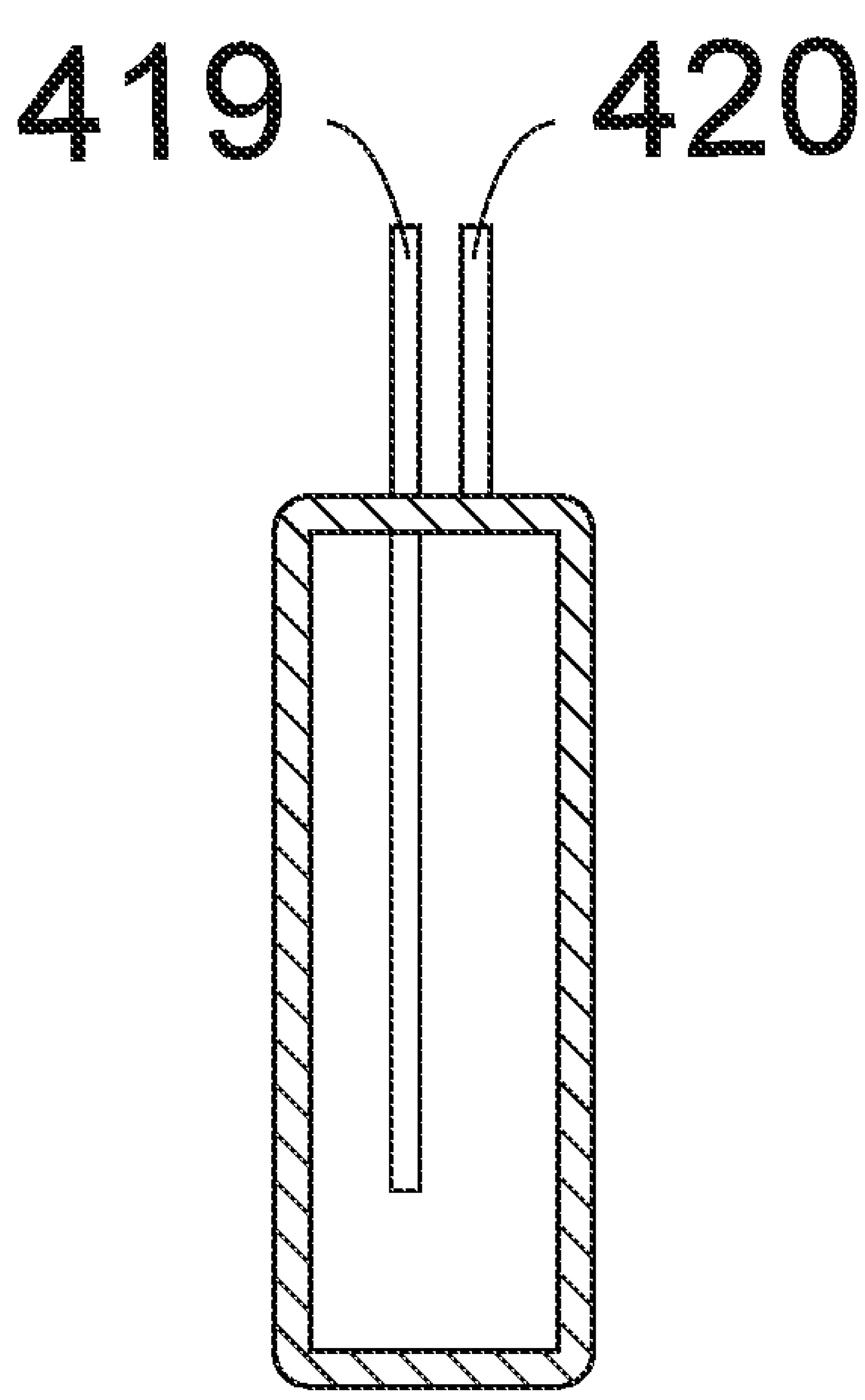

FIG. 10D

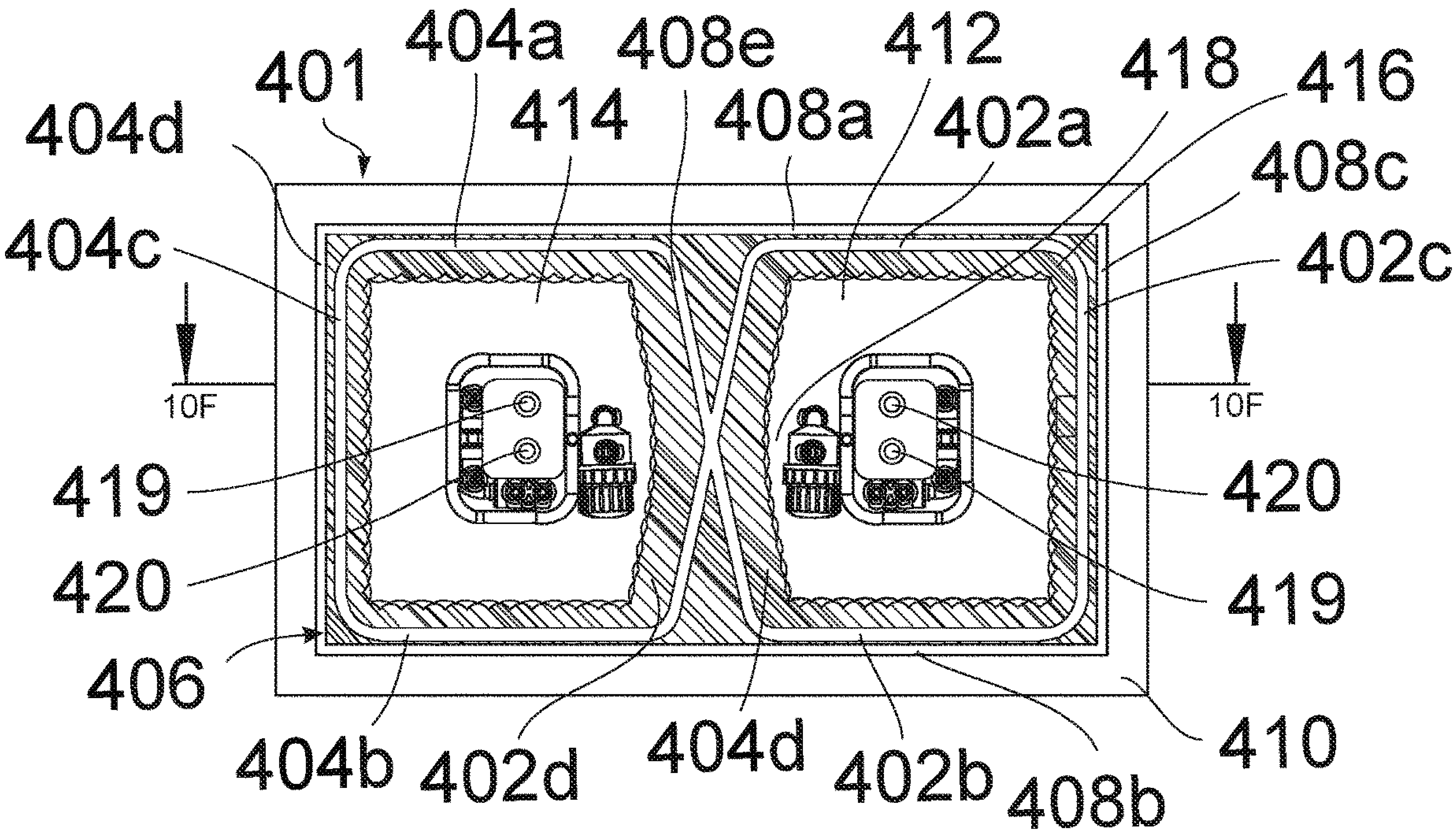

FIG. 10E

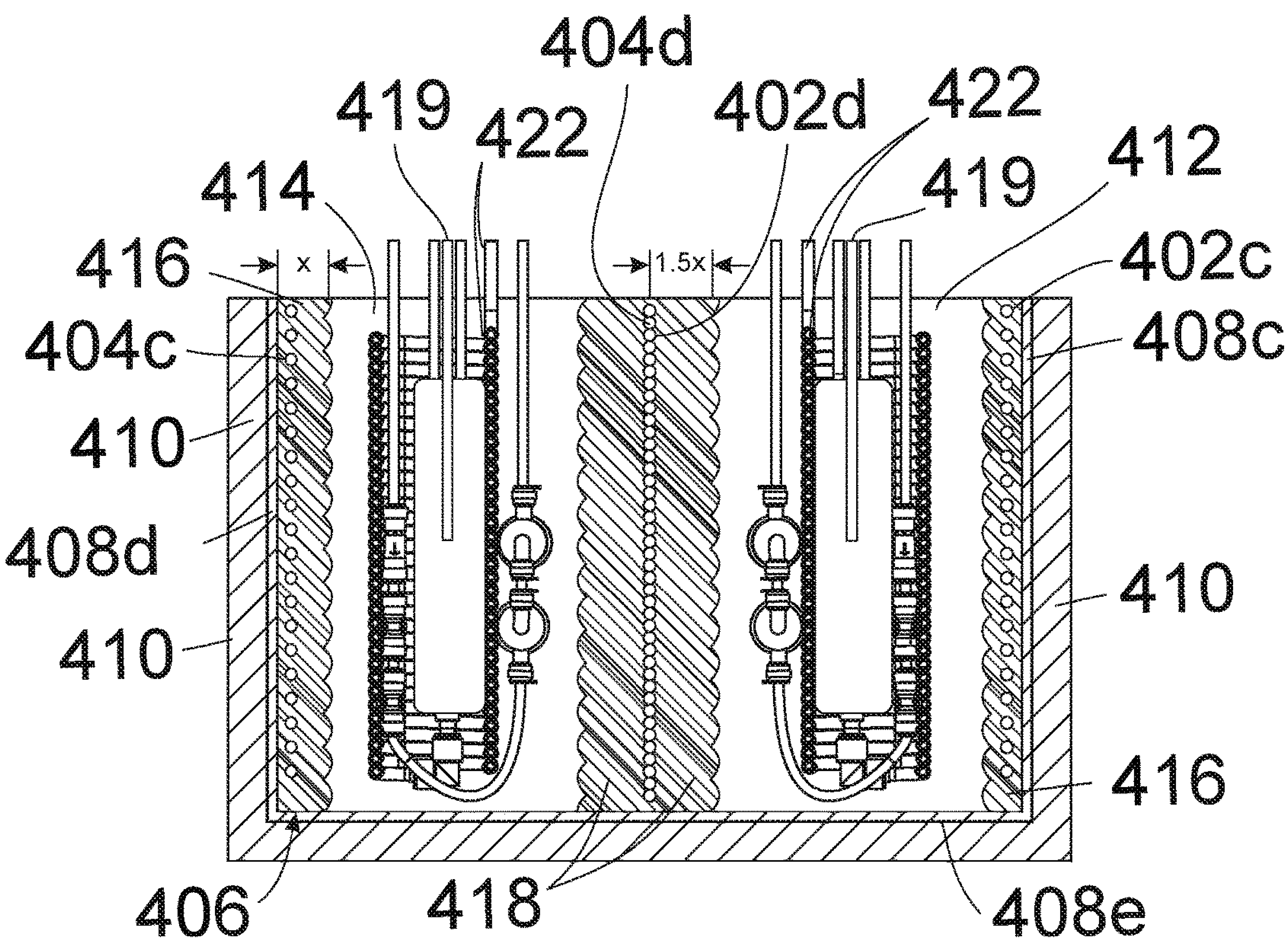

FIG. 10F

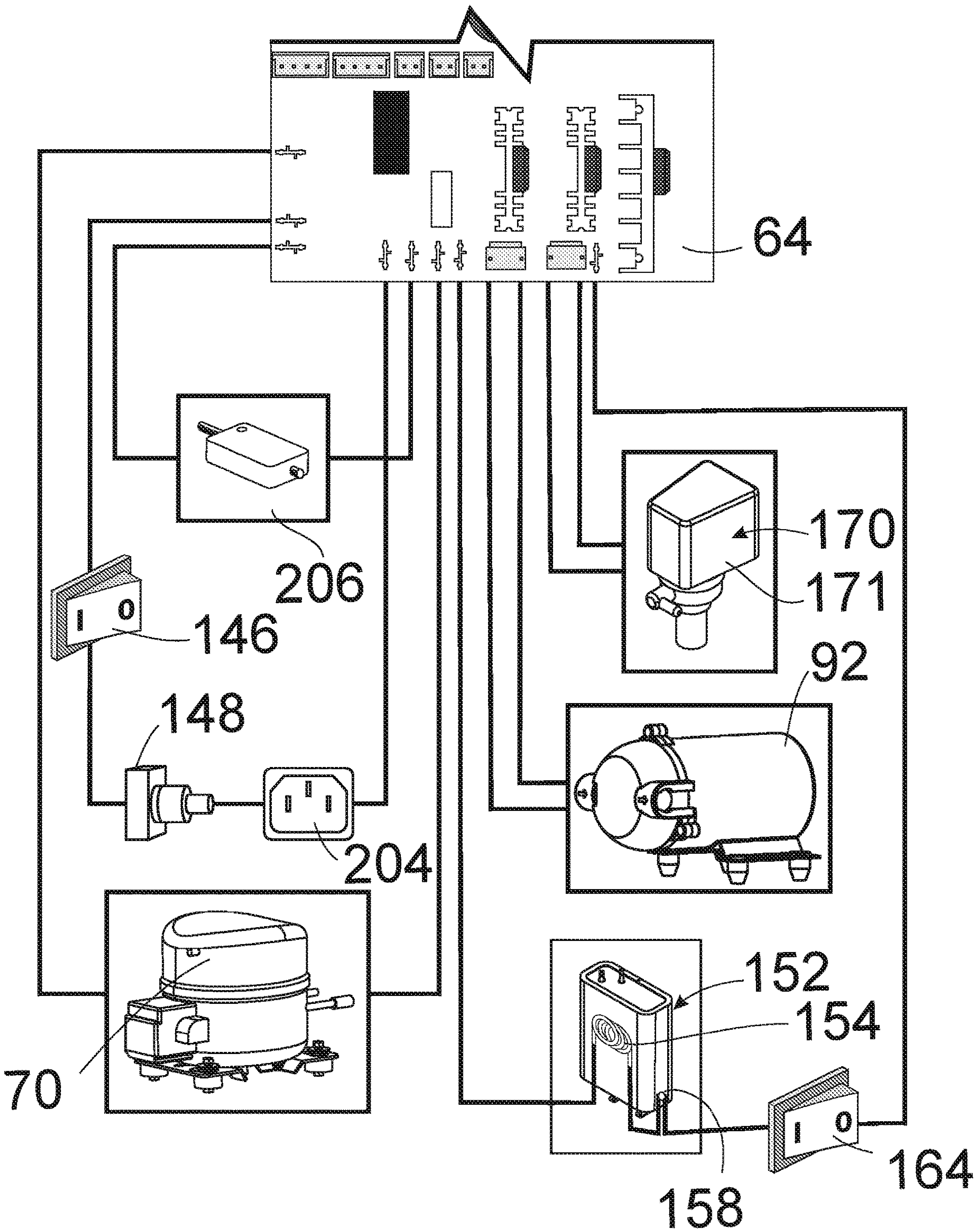

FIG. 11A

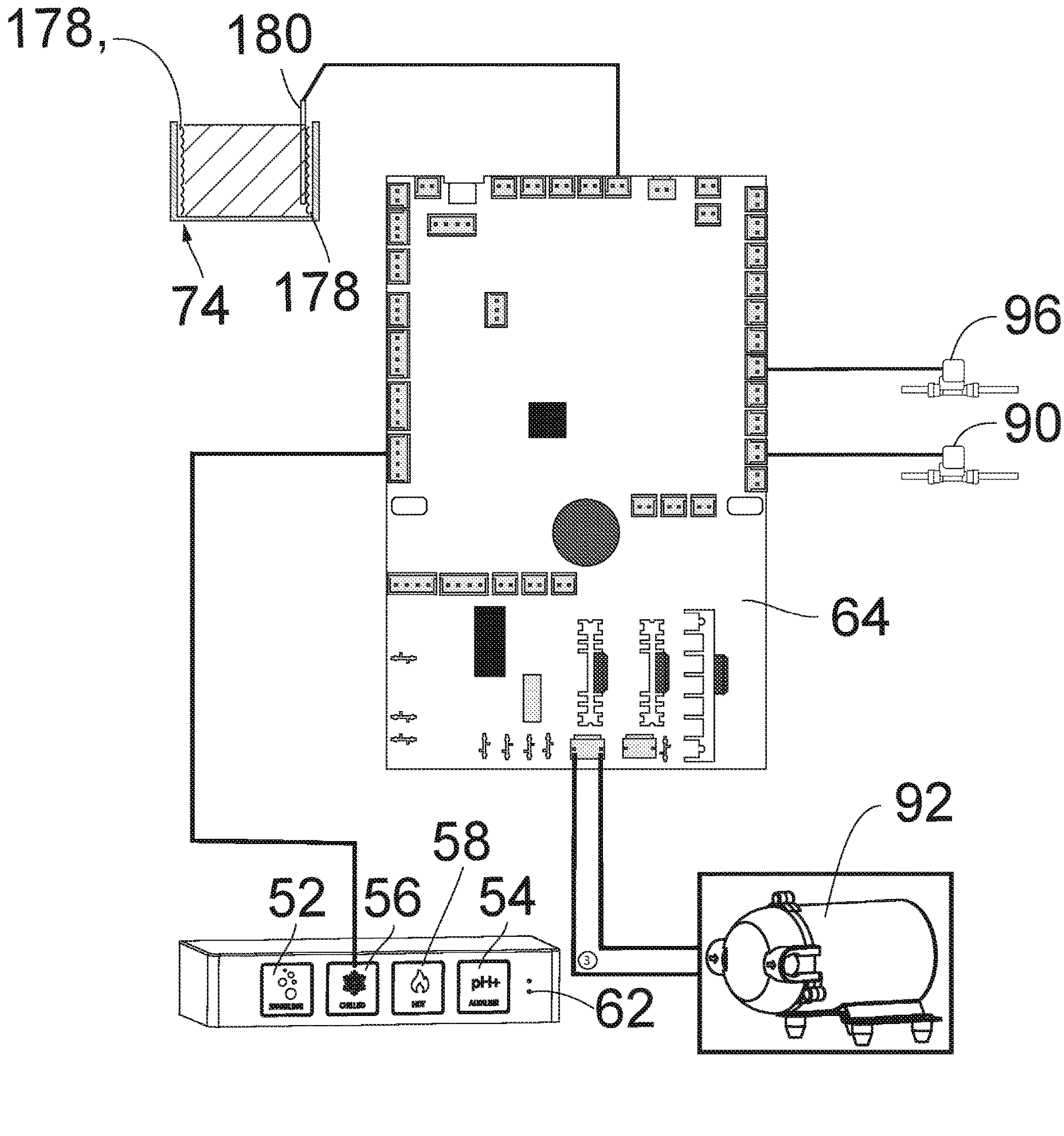

FIG. 11B

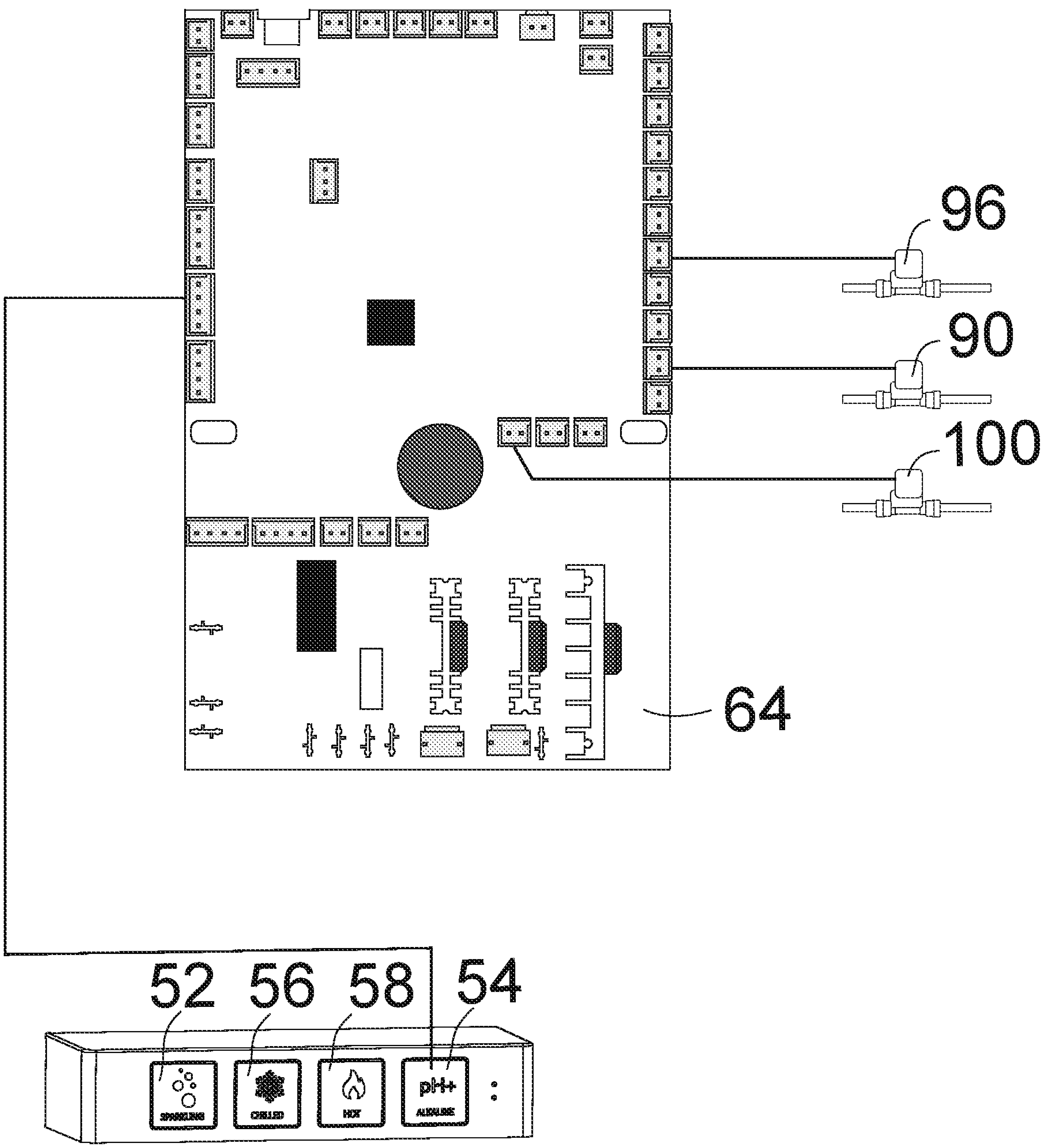

FIG. 11C

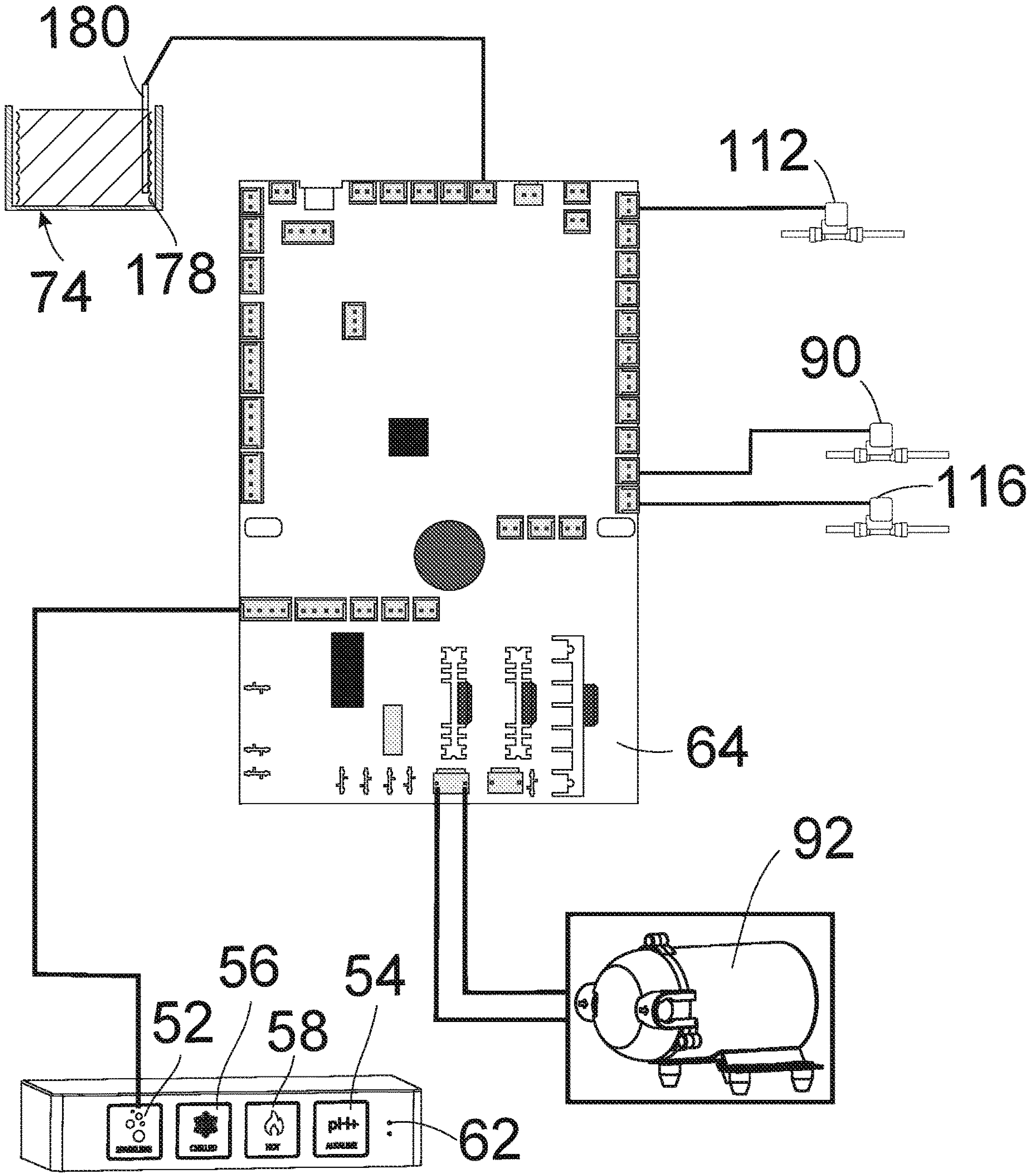

FIG. 11D

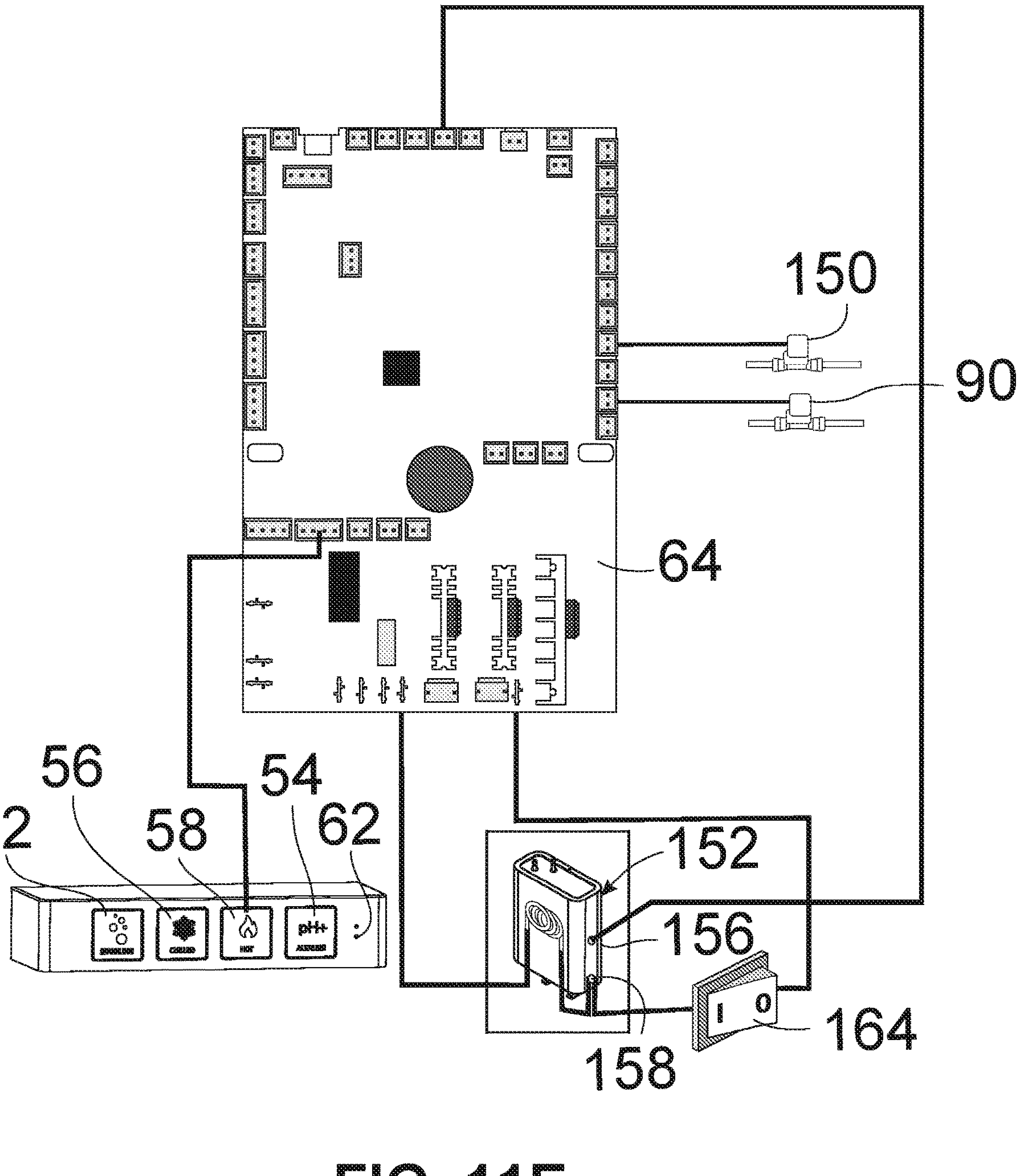

FIG. 11E

WATER DISPENSING STATION

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 16/875,975 filed May 15, 2020, which application claims priority to U.S. Provisional Application No. 63/006,652 filed Apr. 7, 2020, and to U.S. Provisional Application No. 62/849,796 filed May 17, 2019, the disclosures of each of which applications are incorporated herein by reference in their entireties.

STATEMENT RE: FEDERALLY SPONSORED RESEARCH/DEVELOPMENT

Not applicable

BACKGROUND

Water dispensers of different sizes and features are nowadays available in homes, offices and restaurants. But there are several beverages that current dispensers do not dispense and there is thus a need for dispensers that dispense a wider and different variety of waters with different chemical characteristics, such as alkaline waters, or water at different temperatures with different carbonation levels.

Some water dispensers typically provide carbonated water by mixing carbon-dioxide gas with chilled water that is injected at high pressure—using a pump—inside a pressurized canister (i.e., a metal vessel under pressure). When the pressurized canister is full of water mixed with gas, users can dispense the carbonated water contained in the pressurized canister until it is empty and the cycle repeats, per batches. There is a need for a dispenser that can create carbonated water or other carbonated beverages instantaneously, on demand and continuously (i.e., not per batches), without using a pressurized canister to hold a specific volume of carbonated water (pre-carbonated), but using instead a small, efficient, continuous and no-energy consuming in-line flash carbonator, such as the carbonator using electrostatic charging as in U.S. patent application Ser. No. 16/329,043, filed Feb. 27, 2019 and published as Publication No. 2019/0217256 on Jul. 18, 2019. While current art carbonated beverage dispensers use a pressurized canister to combine carbon dioxide gas with water, the space occupied by such vessel under pressure increases the overall dimensions of its chiller and reduces the energy efficiency of its chiller. There is therefore a need for a dispenser whose carbonation system is small and efficient and whose refrigeration system can also be compact and efficient.

Commercial-grade water dispensers that are able to dispense carbonated water and carbonated beverages must have very powerful refrigeration systems because it is a well-known principle of physics that the solubility level of carbon-dioxide gas in water and the formation of carbonic acid is related to the temperature of water: solubility is maximum when the temperature of the water approaches the water-freezing temperature (i.e., 0° C.).

Chillers have refrigerated evaporator coils immersed in a water-bath inside a chilled water reservoir, with water dispenser cooling coils in the same water bath to refrigerate the drinking water that is produced by the dispenser. Such water dispensers use the so-called "water-bath/ice-bank" technology, where the latent heat of the ice that it is formed all around the evaporator coils is used to flash refrigerating the

drinking water that enters the chiller. There is further the need of refrigerators for water dispensers to have an efficient chilling system.

Chillers are normally shipped with their chilled water reservoir empty to avoid the weight and leakage of the water during shipping. Thus, during installation and setup of a dispenser, the installer or the user must fill manually the chilled water reservoir with large volumes of water and associated spilling, splashing and overfilling errors. If, overtime, water evaporates from the reservoir, it must also be manually refilled. There is thus a need for a light water dispenser suitable for shipping that avoids the problems associated with manual filling and refilling of the chilled water reservoir. There is a further need for emptying such chilled water reservoirs when the water dispensers must be moved or discarded.

Further, the cooling evaporator coils freezes the water in the chilled water reservoir and temperature sensors are used to limit the amount of ice formed. When the ice growth is such that it touches the temperature sensor then if the compressor does not stop working the entire water-bath inside the chiller might freeze-up and, consequently, the drinking water that flows inside a stainless steel drinking water chill water coil immersed inside the chiller reservoir whose water bath freezes up completely and cannot be dispensed. There is a need for more accurate control over the amount of ice formed so the latent-heat of ice can be used to increase the cooling efficiency of the cooling coils in the water reservoir and so that agitators inside the chiller are controlled by the temperature of the drinking water in the chiller water coil, rather than based upon the growth of the ice, or any other time-related variable.

Water dispensers with evaporator cooling coils immersed in the chilled water reservoirs provide a limited supply of cooled water contained in the dispenser, that supply may be depleted during periods of high demand. There is thus a need to increase the capacity for cooled water by increasing the heat-exchange between the surfaces at the interface between the ice and the water, creating the necessary agitation of the water inside the chiller while avoiding unnecessarily melting the ice when the temperature of the drinking water inside the water chiller coil is low enough. There is further the need of water-bath agitators that increase heat transfer by convection by directing water in the appropriate direction.

There is the need to avoid too much agitation and consequent consumption and premature melting of the ice bank because of uninterrupted circulation of the water inside the chilled water reservoir. There is further the need of optimizing the use of the latent heat of the ice bank based on demand.

Hot water heaters for beverage dispensers typically use resistance heaters to create hot water in a reservoir, with gravity and water pressure helping dispense the heated water from a spigot in the bottom or side of the dispenser and below the reservoir or a large portion of the hot water reservoir. The hot water can make the spigot hot to the touch. There is a need for an improved water heater that dispenses hot water but with spigot that does not get hot as in the prior art.

In addition, there is believed to be a need that no water remains in the water line between the hot water tank and the spigot at the moment the dispensing of hot water is halted or immediately thereafter. If hot water remains in the outlet line between the tank and the spigot the temperature of the water in the line will decrease over time and when the spigot is opened to dispense hot water again, the hot water dispensed from the spigot would have an inconvenient lower temperature because it will be mixed with the cooler water that has remained in the outlet line. It is, therefore, useful that all the hot water that remains in the outlet line outside the hot water tank and that it is not dispensed, flows back into the hot water tank as soon as the spigot closes, so that the water will remain hot (heated by the heater), instead of stagnating in the outlet line and gradually reducing its temperature.

There is also a need for a hot water tank to be able to dispense heated water upwards (i.e., against gravity), so that the hot water tank could be located below the level of the dispensing nozzle and the resulting design of the entire drink station dispenser is not too high.

Hot water tanks for water dispensers have temperature sensors that shut off power to the electrical resistance heater when steam is generated because that indicates the hot water reservoir is out of water or low on water, and such heaters avoid steam because the steam temperature can result in dispensing water that is too hot. But because steam holds more heat than water, the efficiency of heaters that do not use steam is less lowered. There is a need for a more efficient hot water heating system and for an improved temperature control system for hot water tanks.

Electrical resistance heaters for hot beverage dispensers may overheat when due to the evaporation of water over a certain period of time of no use, the water level in the hot water reservoir becomes too low so that part of the resistance heater is no longer covered with water. There is thus a need for an improved way to avoid overheating of hot water heaters.

The taste of alkaline water is believed to improve if it is consumed at a temperature below ambient. There is thus a need for a compact beverage dispenser that can provide unlimited chilled alkaline water without requiring a large reservoir of chilled alkaline water.

There is also believed to be a need for a constant release of minerals from alkaline chambers containing alkaline ceramic balls and, a need to control and stabilize the release of minerals into the drinking water in order to avoid sudden release of minerals when the dispenser is not used for one day or more.

BRIEF SUMMARY

A number of features are provided in an improved beverage drink station. These improvements include, but are not limited to, a drink station having an alkaline filter cartridge in fluid communication with an ambient temperature water line to dispense alkaline water at a spigot on the dispenser. A chilled water line is in fluid communication with the same spigot, so a mixture of chilled water and alkaline water is provided at the spigot to improve the taste of the alkaline water by slightly reducing its temperature. A hot water tank with heater is located below the spigot so hot water flows upward for dispensing from the spigot to provide hot water at the spigot. A vent line between the hot water tank and spigot help hot water to flow from the spigot, back to the hot water tank and avoid heating the spigot. An external carbon dioxide gas tank provides carbonation to a chilled line of sparkling or carbonated water, and in-line carbonators, immersed in a water-bath that is cooled down by the refrigeration system, provide supplemental carbonation to produce different carbonation levels at the spigot. A figure eight evaporator coil provides two cylindrical ice-banks and two drinking water chiller water coils to increase the chilled water capacity of the drink dispenser. Up to two submersible agitator pumps are used to create a spherical flow path in the opposing top and bottom ends of the chilled water bath to

control the water bath temperature, with a drinking water temperature sensor controlling the agitators.

In more detail, a drink station is shown which has a housing containing a first main water inlet port in fluid communication with a water delivery pump inside the housing to provide water to the delivery pump during use of the apparatus. The dispenser has at least one stainless steel drinking water chiller coil where drinking water is cooled down, in fluid communication with the water delivery pump and the spigot. In order to cool down the incoming water, the stainless steel drinking water chiller coil is at least partially inserted into, and cooled by, a heat exchanger having a low temperature portion to chill incoming water from the water delivery pump to a temperature between the ambient temperature of the water at the delivery pump and just above 32° F. during use of the dispenser.

Such beverage dispenser has an optional first water line splitter that is placed in fluid communication with the drinking water chiller coil, a normally-closed chilled water valve positioned downstream with respect to the drinking water chiller coil and downstream of and in fluid communication with the first water line splitter. A normally closed sparkling water valve may be positioned downstream of the chiller coil and downstream of, and in fluid communication with, the first water line splitter. The sparkling water valve is in fluid communication with a downstream dispensing outlet. At least one normally closed carbon dioxide gas valve may be placed in fluid communication with a carbon dioxide gas tank. At least one first static venturi-restriction device is located downstream of, and in fluid communication with, the carbon dioxide gas valve and is also located downstream of and in fluid communication with the chilled water line splitter. The venturi improves the mixing of chilled water and carbon dioxide gas. One or more static, in-line carbonation devices are optionally located downstream of, and in fluid communication with, at least one first static venturi-restriction device to further carbonate chilled water flowing through at least one first static venturi-restriction device. The in-line venturi-restriction device is at least partially inserted into, and cooled by, the heat exchanger to provide cold carbonated water. The in-line carbonation chambers are in fluid communication with the dispensing outlet which is downstream of the carbonation chambers to dispense that chilled and carbonated water.

The beverage dispenser has an electronic control module that is in electrical communication with the water delivery pump, the water valve, the sparkling water valve, the carbon dioxide gas valve and the chilled water valve to open and close those valves and to power the deliver pump on or off. A chilled water selector is placed in electrical communication with the electronic control module to dispense chilled still water. When the chilled water selector is activated, the controller sends electrical signals to the various parts so that the water delivery pump is powered on and the chilled water valve is excited to open and allow chilled still water to flow to the dispensing outlet during use of the apparatus. A carbonated water selector in also electrical communication with the electronic control module to dispense chilled carbonated water. When the carbonated water selector is activated, the control module sends electrical signals to the various parts so that the water delivery pump is powered on, the sparkling water valve and the carbon dioxide gas valve are both excited to open to allow carbonated water to flow to the dispensing outlet during use of the apparatus.

The above beverage dispensing apparatus includes a normally closed main inlet valve positioned downstream of the main inlet port into the drink station and in electrical communication with the control module to open and close the main inlet valve anytime a selector is activated. When the chilled water selector, or the carbonated water selector is activated, the main inlet valve is excited open. The dispensing apparatus includes a flow-meter in fluid communication with the main inlet port and electrically connected to the control module, to monitor the quantity (e.g., volume) of water dispensed by the dispenser because, except for potential evaporation, the water in the dispenser should equal the water dispensed out of the dispenser.

In still further variations, the dispenser includes an ambient water line that includes a normally closed ambient water valve in fluid communication with the main valve and the dispensing outlet and in electrical communication with the control module to open and close the ambient water valve. An ambient water selector is in electrical communication with the electronic control module to dispense ambient temperature water. When the ambient water selector is activated the controller powers the water delivery pump on and opens the ambient water valve to allow ambient temperature water to be dispensed during use of the apparatus.

In further variations, the beverage dispensing apparatus also dispenses alkaline water. In this case, a normally closed ambient water valve in is in fluid communication with the main water inlet port to receive water during use and further in electrical communication with the control module to open and close the ambient water valve. An alkaline cartridge has an inlet downstream of and is in fluid communication with the ambient water valve and further has a cartridge outlet in fluid communication with an alkaline water line. The alkaline cartridge contains at least one and preferably several different alkaline minerals and a downstream bed of activated granular carbon that is in fluid communication with the alkaline cartridge outlet. A filter membrane is interposed between the alkaline mineral and the charcoal bed to separate the materials, avoid sudden release of alkaline minerals and filter out larger mineral particles. In this configuration, the beverage dispenser has an alkaline selector in electrical communication with the electronic control module to dispense alkaline water by opening both the chilled water valve and the ambient water valve to allow ambient temperature water to flow through the alkaline cartridge and into the alkaline water line. The chilled water line is also in fluid communication with the alkaline water line (preferably at the dispensing outlet) to dispense a mixture of chilled water and alkaline water at the dispensing outlet during use of the dispensing apparatus in order to reduce the temperature of the dispensed alkaline water while contemporarily diluting the amount of minerals released at the spigot.

In further variations, the controller has a timing circuit that opens and then closes the chilled water valve for a time interval which is shorter than the time interval during which the ambient water valve is opened and then closed. Additionally, the alkaline chamber includes a cartridge containing mineral alkaline crystal balls. The cartridge is removably connected to a manifold having a manifold inlet in fluid communication with and downstream of the ambient water valve. Connections of the type used with water filters are believed suitable. The manifold has a manifold outlet that is fluid communication with the alkaline water line at the dispensing outlet.

In still further variations, the drink station dispenses hot water, and addresses a prior problem of not efficiently using the steam that collects in hot water heaters but is never dispensed with the hot water. An improved hot water tank which includes a heater includes a normally closed hot water valve in fluid communication with the main valve and in electrical communication with the control module to open and close the hot water valve and the main valve. A hot water tank is provided having a hot water reservoir in a bottom portion of the tank and a vapor chamber at a top portion of the tank with a dividing wall separating the hot water reservoir from the vapor chamber. A discharge opening in the dividing wall places the hot water reservoir in fluid communication with the vapor chamber, so steam can flow into the vapor chamber whether the water reservoir is full, or partially full. A tube with a slotted bottom connects the discharge opening to an outside of the tank. The tank has a fluid inlet at a bottom of the tank in fluid communication with both the hot water valve and the hot water reservoir. The tank also has a hot water outlet at a top of the tank in fluid communication with the hot water reservoir and the vapor chamber, so water flows into the bottom of the tank through the control tube and out the top of the tank during use of the apparatus, sucking steam into the control tube as water flows through the tube. The hot water outlet is in fluid communication with the dispensing outlet through a hot water line. The hot water tank for the dispenser may have an electrical resistance heater in thermal communication with the hot water reservoir in the tank to heat water in the hot water tank during use of the apparatus. The heater is in electrical communication with the control module to control the heater. A hot water selector is provided on the dispenser and placed in electrical communication with the electronic control module to dispense hot water. When the hot water selector is activated the control module sends electrical signals to excite the hot water valve open and the main valve open, so water flows into the hot water tank and it is accelerated upward by the restriction of the slotted control tube where the water from the hot water reservoir flows out the hot water outlet to the dispensing outlet during use of the apparatus.

In further variations of the hot water dispenser, the dispensing outlet is higher than the hot water outlet so hot water flows upward to the dispensing outlet from the hot water tank which is positioned at a lower level. A vapor line is in fluid communication with the dispensing outlet and the vapor chamber to provide a vent path allowing hot water to flow from the discharge opening back into the hot water tank when dispensing stops and the hot valve is closed. The hot water dispensing outlet may be in fluid communication with both the chilled water outlet and the sparkling water outlet as the temperature of the dispensing outlet is not in continuous contact with hot water. Further, the tube advantageously comprises a control tube having a slotted bottom encircling the discharge opening and further having a top forming the hot water outlet. The slots are sized to suck vapor from the vapor chamber when hot water flows through the control tube at a predetermined flow rate of 1 liter per minute minimum. The heater advantageously includes a safety thermostat in contact with the heating element and in electrical communication with the control module to shut off the heating element if the temperature of the hot water is too high or the water level in the water reservoir is too low.

In further variations of the beverage dispensing apparatus, a water filter is placed in fluid communication with and upstream of both the chilled water valve and the sparkling water valve.

To cool down the drinking water the heat exchanger uses a water-bath and ice-bank refrigeration device. Such a device includes a chilled water reservoir having top and bottom walls and sidewalls forming an enclosed water reservoir of predetermined volume, with all walls being thermally insulated. The device has a freezer expansion line with an evaporator coil inside and adjacent to the chilled water reservoir sidewalls. The evaporator coil has sufficient cooling capacity during the use of the apparatus to freeze the water inside the chilled water reservoir which is in contact with the evaporator coil and create an ice bank around a majority of the evaporator coils with the rest of the water-bath inside the chilled water reservoir to remains in its liquid state. The ice-bank is created around all, or almost all the evaporator coils. The device has a drinking water chiller coil located inside the chilled water reservoir and it is at least partially submerged by the water-bath in the reservoir. During use of the drink station, the drinking water inside the chiller coil is cooled down thanks to the ice-bank that is formed on the evaporator coil. One or more static, in-line carbonation chambers are located inside the chilled water reservoir at a location where the carbonation devices are at least partially immersed in the water-bath during use of the dispensing apparatus.

In further variations, the water-bath and ice-bank refrigeration device has the first splitter for the chilled water line and the carbonated water line located inside the chilled water bath during use of the apparatus. Additionally, a first temperature sensor may be placed in electrical communication with the controller and positioned within the chilled water reservoir at a location selected to contact the ice bank along a majority of the length of the sensor during use of the apparatus. The temperature sensor is also in electrical communication with the control module. By measuring the resistivity values that differ significantly between water and ice, the temperature sensor is able to recognize when ice has grown, sends a signal to the electronic control module so that the power to the compressor and fans of the dispenser's refrigeration system is interrupted. The evaporator coils stop freezing water and the growth of ice is interrupted so as to avoid the total freezing of the water inside the chilled water reservoir and of the drinking water inside the stainless steel chiller coil and inside the pipes and connections immersed in the water-bath of the chiller.

In further variations, improved water-bath agitation is done through the use of at least one agitator pump which is proved much more effective in increasing the heat transfer between the ice bank and the water bath than ordinary stirrers or other agitators. In further variations the agitation of the water-bath is done with a first submersible agitator pump having a first pump having a first axial flow path the inflow along a longitudinal axis of the of the drinking water chiller coil while the outflow direction is horizontally directed. The water intake being longitudinally directed towards the pump body on a longitudinal axis, while the water flow is accelerated by the agitator pump and the outflow is directed radially in one, or multiple radial outward directions, on a plane that is orthogonal to that longitudinal axis. More than one agitator pump can be used, so the dispensing device may include a second submersible agitator pump having a submersible pump having a third axial flow path along the longitudinal axis of the drinking water chiller coil and in a direction opposite to the first axial flow path. The second submersible agitator pump and its pump have fourth radial flow path orthogonal to that longitudinal axis and in the same direction as the second radial flow path.

In further variations, the agitators include first and second submersible agitators with pumps with each agitator pump at least partially submerged in the water-bath of the chilled water reservoir. Each submersible pump has first and second respective nozzles extending along a longitudinal axis of the drinking water chiller coil and forming the inflow port. Each submersible agitator pump has a plurality of second ports forming the outflow port directing the water outward in a radial way, with each submersible agitator's inflow and outflow ports creating a circular flow path in a portion of the chilled water reservoir.

In further variations, an improved temperature control for the ice bank is provided. At least one agitator pump is at least partially inside the drinking water chiller coil and in electrical communication with the controller. The at least one agitator pump is preferably at least partially submerged. An ice contact temperature sensor located in the chilled water reservoir at a location that contacts the ice bank during use of the apparatus which sensor is also in electrical communication with the controller. During use of the apparatus the ice bank grows and contacts the ice contact temperature sensor which then sends a signal to the controller, and in response to that signal the controller activates or de-activate the compressor and the fans of the refrigeration system.

In further variations, an improved chilled water reservoir is provided. The chilled water reservoir is advantageously sealed to contain the chilled water in a sealed environment that reduces water spillage and evaporation. A normally closed, chilled water reservoir filling valve is provided having an upstream end in fluid communication with the main flow valve and a downstream end in fluid communication with a chilled water reservoir fill line that is in fluid communication with the chilled water reservoir. A water level sensor is located to detect the water level in the chilled water reservoir. The bucket fill valve and the water level sensor are each in electrical communication with the controller which has circuitry configured to open the chilled water reservoir filling valve when the water level sensor reaches a predetermined low level determined by the sensor and to close the reservoir filling valve when the water level sensor is at a maximum fill level determined by the sensor signal. A float sensor is believed suitable. In further variations, the chilled water reservoir comprises top and bottom walls and sidewalls forming a sealed enclosed of predetermined volume, with all walls being thermally insulated and at least a majority of the fluid communication lines and electrical communication lines extending through sealed fluid connections in the top of the chilled water reservoir. Advantageously, a drain is provided in the bottom of the water reservoir to remove the water bath from inside the reservoir when the dispenser is deinstalled and moved from one location to another.

A beverage dispensing apparatus with increased capacity is also provided. A beverage dispenser housing has a first main water inlet port in fluid communication with a water delivery pump in the housing to provide water to the delivery pump during use of the apparatus. A chilled water reservoir has top and bottom walls and sidewalls forming an enclosed water reservoir of predetermined volume, with all walls being thermally insulated and advantageously, but optionally, sealed to provide a sealed enclosure for the chilled water reservoir. If the lid is removable, a ring seal, such as an O-ring seal, is provided. The apparatus has an evaporator freezer having an evaporator coil inside and connected to the chilled water reservoir sidewalls. Advantageously, the evaporator coil forms a figure eight configuration having a first vertical evaporator coil at a first end of the figure eight configuration and a second vertical evaporator coil at a second end of the figure eight configuration. The evaporator coils have interleaved connecting segments extending between the first and second vertical evaporator coils. The evaporator coil has sufficient cooling capacity during use of the apparatus to freeze water in contact with the evaporator coil and create a wall ice bank around at least a majority of the area of the sidewalls and to create a center ice bank extending between two opposing sidewalls of the water reservoir where the interleaved segments of the first and second evaporator coils are interleaved.

The improved capacity dispensing device also has a first vertical chiller water coil located inside the first evaporator coil. The first chiller water coil has an upstream end in fluid communication with the water delivery pump and a downstream end in fluid communication with a first dispensing outlet. A second vertical chiller water coil is located inside the second evaporator coil. The second chiller water coil has an upstream end in fluid communication with the water delivery pump and a downstream end in fluid communication with a second dispensing outlet. This figure eight configuration is believed to provide twice the volume of chilled water as a single coil. Advantageously, each drinking water chilled water coil contains 0.5 to 0.8 liters of chilled water, for a total capacity of 1 to 1.6 liters of chilled water in the drinking water chilled coils.

There is also provided a hot water tank for use in a beverage dispenser having a water inlet and a hot water outlet, and a plurality of beverage selector buttons associated with different beverages. The selector buttons are in electrical communication with a controller to active appropriate valves in the beverage dispenser to dispense the different beverages associated with the respective selector buttons through a discharge opening. One of the selector buttons includes a hot water button. The hot water tank includes a tank housing containing a hot water reservoir in a bottom portion of the housing and a vapor chamber at a top portion of the housing with a dividing wall separating the hot water reservoir from the vapor chamber. A discharge opening extends through the dividing wall with the discharge opening advantageously located in the bottom of a recess in the dividing wall. The hot water housing has a water inlet at a bottom of the housing. A control tube extends from the discharge opening through the vapor chamber and through a top of the housing. A slotted bottom on the control tube encircles the discharge opening at the dividing wall. The slotted bottom has a plurality of longitudinal slots sized to inhibit water that flows through the control tube at a flow rate of, minimum, 1 liter per minute from also flowing through the slots while allowing any steam in the vapor chamber to be sucked into the water flowing through the control tube at a speed determined by the area of the restrictor in the slotted tube and the pressure of the incoming water. The slots are also sized to allow steam from the hot water reservoir to enter the vapor chamber. The tank also advantageously, but optionally, includes a vent tube having a first end in fluid communication with the vapor chamber and a second end outside the housing, with the second end configured to connect to a fluid line during use of the heater. The tank may also have an electrical resistance heater in thermal communication with the hot water reservoir in the housing to heat water in the hot water reservoir during use of the tank. Advantageously, the tank also has a temperature regulating thermostat in thermal communication with the hot water reservoir.

There is also provided a beverage dispenser that has an improved hot water tank for use in dispensing hot water. The beverage dispenser has a water inlet, a hot water outlet, and a plurality of beverage selector buttons associated with different beverages and with each button in electrical communication with a control module to activate appropriate valves in the beverage dispenser to dispense the different beverages associated with the respective selector buttons through a beverage dispensing outlet. One of the selector buttons is a hot water button. The improved beverage dispenser includes a normally closed hot water valve in fluid communication with a normally closed main valve that is in fluid communication with the beverage dispenser's water inlet. The hot water valve is in electrical communication with the control module to open and close the hot water valve. The dispenser has an improved hot water tank that has a hot water reservoir in a bottom portion of the tank and a vapor chamber at a top portion of the tank with a dividing wall separating the hot water reservoir from the vapor chamber. The dividing wall has a discharge opening placing the hot water reservoir and the vapor reservoir in fluid communication. The tank has a water inlet at a bottom of the tank in fluid communication with the hot water valve and the hot water reservoir. The tank having a control tube extending from the discharge opening through a top of the tank and in fluid communication with the hot water reservoir and the vapor chamber, so water can flow into the bottom of the tank and out the top of the tank during use of the apparatus. The tank has a water deflector at the bottom of the hot water reservoir to favor mixing of the ambient temperature water entering the hot water tank during use of the apparatus with the hot water present inside the hot water reservoir. The deflector being able to direct incoming water flow towards the heater. The hot water outlet is in fluid communication with the beverage dispensing outlet through a hot water line, with the beverage dispensing outlet being above the tank's hot water outlet in the vertical direction. The control tube has a slotted bottom encircling the discharge opening at the dividing wall. The slotted bottom has a plurality of slots extending along a length of the control tube and configured to inhibit water that is flowing through the control tube at a flow rate of at least 1 liter per minute from also flowing through the slots while sucking at least some of any steam in the vapor chamber into the water flowing through the control tube. The slots are sized to allow steam from the hot water reservoir to enter the vapor chamber. The dispenser advantageously has an electrical resistance heater in thermal communication with the hot water reservoir in the tank to heat water in the hot water reservoir during use of the apparatus. The heater is in electrical communication with the control module to regulate the operation of the heater. The operation of the heater is regulated by signals from the control module such that when the hot water valve is excited to open, water flows into the hot water reservoir and upward and out the hot water outlet to the dispensing outlet during use of the apparatus.

In further variations, the hot water heater includes a vent tube having a first end in fluid communication with the vapor chamber and a second end outside the heater tank with that second end configured to connect to a fluid line during use of the heater to provide a vent path avoiding air locks and allowing hot water to drain back into the hot water reservoir through the control tube. Advantageously, the heater includes a temperature regulating thermostat in thermal communication with the hot water reservoir, and a thermistor contacting the heater to provide a safety shut off if the water level falls below the level at which the thermistor contacts the heater.

There is also provided an improved agitator pump for a chilled water bath in a beverage dispensing apparatus using a water bath/ice bank cooling system for the dispensed water. The system has a drinking water chiller coil extending along a longitudinal axis of the chilled water reservoir and located in the chilled water bath and an ice-bank surrounding a portion of the chilled water bath inside an insulated water reservoir having an evaporator coil of the refrigeration system that forms the ice bank. The improved agitator pump including first and second submersible agitators each having a submersible agitator pump with at least one intake port creating a first flow path during use that extends along the longitudinal axis of the chiller coil. Both the first ports face each other along that longitudinal axis. Each submersible pump also has a plurality of second outlet ports orientated outward from the longitudinal axis and creating an outflow path during use that extends outward from the longitudinal axis. The intake port and the outlet openings in each of the two agitator pumps cooperate during use to intake water longitudinally through the intake port and expel water on an orthogonal plane, radially, through the outlet openings. Both ports are located in the chilled water bath inside the chilled water coil during use. Further, the two ports cooperate to create a spherical flow pattern in the portion of the chilled water reservoir by each agitator pump which flow pattern keeps the drinking water chiller coil from freezing and controls the thickness of the ice bank. Advantageously, each spherical flow pattern extends to about half the height of the drinking water chiller coil.

In further variations, the at least one agitator pump operates in cooperation with a temperature sensor which controls the temperature of the water inside the drinking water chiller coil, to send an electrical signal indicating when the temperature of the drinking water exceeds a certain upper value or is reduced below a lower value. The two values are used to turn the agitator pump(s) on and off, or to change their speeds or, alternatively, to turn off one agitator pump while keeping the other working.

Yet a further beverage dispensing apparatus is disclosed herein. Such apparatus comprises a chilled water reservoir; a refrigeration system comprising an evaporator coil, wherein the evaporator coil is arranged within the chilled water reservoir and is configured to freeze water within the chilled water reservoir to form an ice bank; an ice sensor configured to detect a presence of ice within the chilled water reservoir; a controller in communication with the ice sensor, wherein the controller is configured to deactivate the refrigeration system when the presence of ice is detected; a chiller coil arranged within the chilled water reservoir configured to circulate drinking water; an agitator pump arranged within the chilled water reservoir and configured to circulate the chilled water in the chilled water reservoir; and a temperature sensor arranged adjacent to the chiller coil and in communication with the controller, wherein the controller operates the agitator pump based on a temperature determined by the temperature sensor.

In further variations, the beverage dispensing apparatus may further include, at least one first static venturi-restriction device located downstream the sparkling water valve of and in fluid communication with the carbon dioxide gas valve and also located downstream of and in fluid communication with the chilled water line splitter. Further, the apparatus may also include one or more static, in-line carbonation devices downstream of and in fluid communication with the at least one first static venturi-restriction device to further carbonate water flowing through the at least one first static venturi-restriction devices. The in-line venturi-restriction device is at least partially inserted into and cooled by the heat exchanger and the carbonation devices are in fluid communication with the dispensing outlet downstream of the carbonation devices. There is also provided a beverage dispensing apparatus for alkaline drinks that includes a normally closed ambient water valve in fluid communication with the main water inlet port of the dispensing apparatus to receive water during use and in electrical communication with the control module to open and close the ambient water valve. The alkaline drink dispensing apparatus also has an alkaline cartridge having an inlet downstream of and in fluid communication with the ambient water valve and also having a cartridge outlet in fluid communication with an alkaline water line.

The apparatus further includes an alkaline cartridge containing at least one alkaline mineral and a downstream bed of activated granular carbon that is in fluid communication with the alkaline cartridge outlet. An alkaline selector is in electrical communication with an electronic control module to dispense alkaline water by opening the ambient water valve to allow ambient temperature water to flow through the alkaline cartridge and into the alkaline water line.

In further variations, the alkaline water dispensing apparatus has an alkaline chamber that includes a cartridge containing mineral ceramic balls. The cartridge is removably connected to a manifold having a manifold inlet in fluid communication with and downstream of the ambient water valve. The manifold also has a manifold outlet that is fluid communication with the alkaline water line. In still further variations, the alkaline water dispensing apparatus has a refrigeration system to refrigerate and chill water, with a normally closed chilled water valve that can be activated by a controller to dispense chilled water from the refrigeration system. The dispensing apparatus also has an outlet in fluid communication with both the alkaline water line and the chilled water line. The controller also opens and then closes both the ambient water valve and the chilled water valve to dispense a mixture of chilled water and alkaline water at the dispensing outlet during use of the dispensing apparatus. In still further variations, the alkaline water dispensing apparatus has the chilled water valve opening for a time interval which is shorter than the time interval during which the ambient water valve is opened and then closed.

There is also provided a beverage dispensing apparatus having a hot water dispensing outlet for hot water drinks that includes a normally closed hot water valve in fluid communication with a hot water tank positioned downstream with respect to the hot water valve. The hot water valve is in electrical communication with an electronic control module. The hot water tank has a hot water reservoir in a bottom portion of the tank and a vapor chamber at a top portion of the tank with a dividing wall separating the hot water reservoir from the vapor chamber and a discharge opening in the dividing wall. The tank has a fluid inlet at a bottom of the tank in fluid communication with the hot water valve and the hot water reservoir. The beverage dispensing apparatus also has an electrical resistance heater in the hot water reservoir in electrical communication with the electronic control module. The electrical heater is operated by a temperature sensor, wherein when the temperature sensor detects a temperature below a certain value the heater is powered on and when the temperature sensor detects a temperature above a certain value is powered off, so that the heater's electrical power is cycling between an upper and a lower temperature. The electrical heating element may be enclosed in a stainless-steel protective cylinder in thermal contact with the water inside the hot water reservoir and heating the water inside the reservoir in a way that its temperature is always kept in between the cycling temperatures. The hot water tank has a hot water outlet at a top of the tank in fluid communication with both the hot water reservoir and the vapor chamber, so water flows into the bottom of the tank and out the top of the tank during use of the apparatus. The hot water outlet is in fluid communication with the hot water dispensing outlet through a hot water line.

With the dispensing outlet for the hot water located at higher level than the hot water tank so hot water must flow upward to the hot water dispensing outlet during operation of the apparatus.

The beverage dispensing apparatus also has a vapor line in fluid communication with the dispensing outlet and the vapor chamber in the hot water tank to provide a vent path allowing hot water to flow from the discharge opening to the outlet and back into the vapor chamber and into the hot water tank after the hot water valve is closed. Further, a control tube is provided having a slotted bottom encircling the discharge opening and further having a top forming the hot water outlet, the slots sized to suck vapor from the vapor chamber when hot water flows through the control tube at a predetermined flow rate. A hot water selector is placed in electrical communication with the electronic control module to dispense hot water, wherein when the hot water selector is activated the control module sends electrical signals to excite the hot water valve open, so water flows into the hot water reservoir and upward and out the hot water outlet to the dispensing outlet during use of the apparatus.

In further variations, the beverage dispensing apparatus may include a safety thermostat positioned on the external walls of the hot water tank and in electrical communication with the control module to shut off the heating element if the temperature in the hot water tank is too high. In still further variations, the apparatus includes a hot water tank, a hot water valve and a hot water line in fluid communication with the hot water dispensing outlet. Still further, an alkaline water chamber, an alkaline water valve and an alkaline water line may be placed in fluid communication with the hot water dispensing outlet, with the hot water dispensing outlet in fluid communication with at least one of a chilled water outlet, a sparkling water outlet and an alkaline water outlet.

In still further variations, the beverage dispensing apparatus has each of the outlets in fluid communication with the hot water outlet. The beverage dispensing apparatus may use a heat exchanger using a water-bath and ice-bank refrigeration device. The refrigeration device may include a chilled water reservoir having top and bottom walls and sidewalls forming an enclosed water reservoir of predetermined volume, with all walls being thermally insulated. The refrigeration device also includes a freezer expansion line having an evaporator coil inside the chilled water reservoir and connected to the chilled water reservoir sidewalls, the evaporator coil having sufficient cooling capacity during use of the apparatus to freeze water in contact with the evaporator coil and create an ice bank around a substantial majority of the freezer coils with a chilled water bath inside the ice bank. A drinking water chiller water coil is located inside the chilled water bath and inside the ice bank to chill water flowing through the chiller coil during use. One or more static, in-line carbonation devices are located inside the chilled water reservoir at a location where the carbonation devices are at least partially immersed in the water bath during use of the apparatus.

In further variations of the beverage dispensing apparatus, at least one agitator pump is provided that includes a submersible pump having a first axial flow path along a longitudinal axis of the chiller coil in an inflow direction, and having a second radial flow path orthogonal to that longitudinal axis and in the outflow direction. The beverage dispensing apparatus may include first and second agitator pumps that are each at least partially submerged in the chilled water reservoir during use, each agitator pump having first and second respective inlet ports extending along a longitudinal axis of the chiller coil and forming their inflow ports, each agitator pump having a plurality of outlets forming the outflow ports with each agitator pump's inflow and outflow ports creating a circular flow path in a portion of the chilled water reservoir.

Further variations of the beverage dispensing apparatus may include at least one agitator pump at least partially inside the chiller coil and in electrical communication with the controller and an ice contact temperature sensor located in the chilled water reservoir at a location that contacts the ice bank during use of the apparatus which sensor is also in electrical communication with the controller. During use of the apparatus the ice bank grows and contacts the ice contact temperature sensor which then sends a signal to the controller, and in response to that signal the controller activates the refrigerator device by powering off a compressor and fans of the refrigerator device when the growth of the ice-bank reaches the temperature sensor.

In still further variations, the beverage dispensing apparatus may include a normally closed, chilled water reservoir filling valve having an upstream end in fluid communication with the main water source and a downstream end in fluid communication with a chilled water reservoir fill line that is in fluid communication with the chilled water reservoir. A water level sensor is located on top of the chilled water reservoir to detect the water level in the chilled water reservoir. The chilled water reservoir filling valve and the water level sensor are each in electrical communication with the controller which has circuitry configured to open the chilled water reservoir filling valve when the water level sensor reaches a predetermined low level determined by the sensor and to close the chilled water reservoir filling valve when the water level sensor is at a maximum fill level determined by the sensor.

There is also provided a beverage dispensing apparatus for dispensing a plurality of beverages that includes a housing having a first main water inlet port in fluid communication with a water delivery pump in the housing to provide water to the delivery pump during use of the apparatus. This apparatus also includes a chilled water reservoir having top and bottom walls and sidewalls forming an enclosed water reservoir of predetermined volume, with all walls being thermally insulated. A freezer expansion line has an evaporator coil inside and connected to the chilled water reservoir sidewalls. The evaporator coil forms a figure eight configuration having a first vertical coil at a first end of the figure eight configuration and a second vertical coil at a second end of the figure eight configuration. The evaporator coils have interleaved connecting segments extending between the first and second vertical coils, the evaporator coil has sufficient cooling capacity during use of the apparatus to freeze water in contact with the evaporator coil and create a wall ice bank around at least a majority of the area of the sidewalls and to create a center ice bank extending between two opposing sidewalls of the water reservoir where the interleaved segments of the first and second freezer coils are interleaved.

This apparatus also includes a first vertical drinking chiller water coil located inside the first evaporator coil and having an upstream end in fluid communication with the water delivery pump and a downstream end in fluid communication with a dispensing outlet. A second vertical drinking water chiller coil is located inside the second evaporator coil and has an upstream end in fluid communication with the water delivery pump and a downstream end in fluid communication with a dispensing outlet.

There is also provided a hot water tank for use in a beverage dispenser apparatus having a water inlet and a hot water outlet, and a plurality of beverage selector buttons associated with different beverages, the selector buttons being in electrical communication with a controller to activate appropriate valves in the beverage dispenser to dispense the different beverages associated with the respective selector buttons through a discharge opening, and with one of the selector buttons including a hot water button. This hot water tank includes a hot water tank housing containing a hot water reservoir in a bottom portion of the housing and a vapor chamber at a top portion of the housing with a dividing wall separating the hot water reservoir from the vapor chamber, and with a discharge opening in the dividing wall, and with the housing having a water inlet at a bottom of the housing. A control tube extends from the discharge opening through the vapor chamber and through a top of the housing. The control tube has a slotted bottom encircling the discharge opening at the dividing wall. The slotted bottom has a plurality of slots configured to inhibit water that flows through the control tube at a flow rate above 1 liter per minute from also flowing through the slots while sucking any steam in the vapor chamber into the water flowing through the control tube. The slots are sized to allow steam from the hot water reservoir to enter the vapor chamber. An outlet is provided for the hot water dispensing from the apparatus, with the outlet positioned at a higher location with respect to the hot water tank housing and the control tube so that hot water is flowing out of the hot water reservoir in an upward direction. A vent tube has a first end in fluid communication with the vapor chamber and a second end outside the housing, with the second end configured to connect to a vapor line during use of the heater. An electrical resistance heater is placed in thermal communication with the hot water reservoir in the housing of the hot water tank to heat water in the hot water reservoir during use of the tank. A temperature sensor, preferably a temperature regulating thermostat having a negative temperature coefficient (NTC) sensor, is in thermal communication with the hot water reservoir.

In further variations, this hot water tank also may include a control tube having a restricted opening at its bottom in fluid communication with the hot water reservoir and having a cross-sectional area of fluid passage that is less than half the cross-sectional area of the control tube. The physical distance between the heater inside the hot water reservoir and a temperature sensor of the NTC is preferably less than 2 mm.

There is also provided a beverage dispensing apparatus having a hot water tank for use in dispensing hot water from the apparatus where the beverage dispenser has a water inlet, a hot water outlet, and a plurality of beverage selector buttons associated with different beverages such that each button is in electrical communication with a control module to activate appropriate valves in the beverage dispenser to dispense the different beverages associated with the respective selector buttons through a beverage dispensing outlet. One of the selector buttons including a hot water button. This beverage dispenser comprises a normally closed hot water valve in fluid communication with a normally closed, main valve that is in fluid communication with the beverage dispenser's water inlet with the hot water valve being in electrical communication with the control module to open and close the hot water valve. A hot water tank has a hot water reservoir in a bottom portion of the tank and a vapor chamber at a top portion of the tank with a dividing wall separating the hot water reservoir from the vapor chamber with the dividing wall having a discharge opening placing the hot water reservoir and the vapor reservoir in fluid communication. The tank has a water inlet at a bottom of the tank in fluid communication with the hot water valve and the hot water reservoir. The tank has a control tube extending from the discharge opening through a top of the tank and in fluid communication with the hot water reservoir and the vapor chamber, so water can flow into the bottom of the tank and out the top of the tank during use of the apparatus. The hot water outlet is in fluid communication with the beverage dispensing outlet through a hot water line, with the beverage dispensing outlet being above the tank's hot water outlet in the vertical direction. The control tube has a slotted bottom encircling the discharge opening at the dividing wall, with the slotted bottom having a plurality of slots extending along a length of the control tube and configured to inhibit water that flows through the control tube at a flow rate of at least 1 liter per minute or above from also flowing through the slots while sucking at least some of any steam in the vapor chamber into the water flowing through the control tube. The slots are sized to allow steam from the hot water reservoir to enter the vapor chamber. An electrical resistance heater is in thermal communication with the hot water reservoir in the tank to heat water in the hot water reservoir during use of the apparatus and the heater is in electrical communication with the control module. Also, a temperature regulating negative temperature coefficient (NTC) sensor is in thermal communication with the hot water reservoir. When the hot water valve is excited to open, water flows into the hot water reservoir and upward and out the hot water outlet to the dispensing outlet during use of the apparatus.

Further variations of this beverage dispensing apparatus include a vent tube having a first end in fluid communication with the vapor chamber and a second end outside the heater tank, with the second end configured to connect to a fluid line during use of the heater. Further a safety thermostat may be provided on the external walls of the hot tank and in electrical communication with the heater, along with a control module and an on/off switch, wherein when the temperature of the hot tank walls exceed a certain value the thermostat opens the electrical circuit avoiding the hot tank to overheat.

Still further variations of this beverage dispensing apparatus include a water deflector in the water inlet port, positioned at the bottom of the hot water reservoir And in fluid communication with a hot water valve, wherein the water deflector deviates the flow path of the incoming water when the hot water valve is open, so as to direct the incoming water towards the heater in order to avoid inlet water to directly flow through the control tube and out, without first mixing with the hot water inside the hot water reservoir, during use of the dispensing apparatus. Still further variations may include a protective stainless-steel shirt around the heater to avoid scale deposit to reduce the thermal efficiency of the heater.

There is also provided an agitator pump that may be completely submerged in a chilled water-bath inside a chilled water reservoir in a beverage dispensing apparatus, where the apparatus has a drinking water chilled coil located at least substantially inside in the chilled water-bath and an ice-bank surrounding a portion of the chilled water bath inside an insulated chilled water reservoir having an evaporator coil with refrigerant fluid that absorbs heat and forms an ice bank. The agitator pump includes a submersible pump with at least one intake port orientated to create an intake flow path during use that is oriented longitudinally with respect to the drinking water chiller coil axis to direct the water-bath surrounding the internal walls of the drinking water chiller coil, towards the inlet port of the agitator. The agitator pump has a plurality of second outlet ports oriented in an orthogonal plan with respect to the intake flow path during use, with the outlet ports extending outward with respect to an intake longitudinal axis. The plurality of outlet ports oriented in a way to direct the outflow path of the water bath towards the ice-bank and the evaporator coil. The at least one inlet port and the plurality of outlet ports cooperate during use of the agitator pump to contemporarily intake and expel the water from the water-bath of the chilled water reservoir.

In further variations, this agitator pump includes an inlet port with the intake flow of this inlet port directed vertically, wherein the agitator pump is located inside the drinking water chilled coil, which extends along a longitudinal axis and is located in the chilled water. The agitator pump has its intake port creating an intake flow path during use that extends along the same longitudinal as the longitudinal axis of the chiller coil with the intake port located inside the chiller coil. The plurality of second outlet openings are orientated outward from the longitudinal axis and create an outflow path during use, extending outward from the longitudinal axis and through the coils of the drinking water chiller coil.

In still further variations, the agitator pump has a plurality of ports oriented to direct the outflow path towards the ice-bank and the evaporator coil, but away from temperature sensors inside the chilled water reservoir. The outlet tubes are preferably connected to the outlet ports bringing the water flow from the agitator pump outlets to the ice-bank, so as to avoid the outlet water path accidentally flowing to and around the temperature sensors inside the water bath.

In still further variations, the agitator pump includes a second agitator pump, wherein the two agitator pumps have their respective inlet ports facing each other, each intake flow oriented vertically, each agitator pump having a plurality of outlet ports orientated outward from the longitudinal axis and creating a second flow path during use extending outward from the longitudinal axis, the ports in each agitator pump cooperating during use to expel chilled water through at least one outlet ports. The inlet and outlet ports are located in the chilled water reservoir to place them completely immersed in the chilled water-bath during use, and both of the two agitator pumps are located inside the same chilled water coil.

In still further variations, the agitator pump may include an ice contact temperature sensor located in the chilled water reservoir at a location that contacts the ice bank during use of the apparatus which sensor sends an electrical signal indicating when the ice bank is in contact with the sensor and when the ice bank is not in contact with the sensor. A drinking water temperature sensor may be placed inside the water bath to control the temperature of drinking water inside the chiller coil, with the sensor sending a first electrical signal to an electronic control module which activates the agitator pump in case the temperature of the drinking water is above a certain upper temperature point and sending a second electrical signal to deactivate the agitator pump when the temperature is below a certain lower temperature point.

In further variations, when the temperature of the drinking water is between the upper temperature point and the lower temperature point, the electronic control module maintains the agitator in its pre-existing conditions: working if it was working, idling if it was not working. In still further variations, the speed of the water outflow expelled varies based on the temperature of the drinking water, with the speed of the one or two agitators starting from zero when the temperature is at or below a certain lower temperature point and increasing in a proportional way as the temperature of the drinking water increases above the lower temperature point.

In still further variations, a second agitator pump as described in any of the above variations may be provided, with the actuation of each agitator pump depending upon the temperature of the drinking water with both agitator pumps working when the temperature of the drinking water inside the chiller coil is above a first predetermined value corresponding to the upper temperature point, and neither of the two agitator pumps is working when the temperature of the drinking water inside the chiller coil is below a second predetermined value corresponding to the lower temperature point, with only one of the two agitator pumps working when the temperature of the drinking water is in between the two temperature points. Preferably, the upper temperature point is 1.2° C. and the lower temperature point is 0.6° C., including a range of +/−0.5° C. from each value.

There is also provided a cup alignment device for a drink dispenser. The drink dispenser has a housing, a spigot for dispensing at least one consumable liquid, a cup support below the spigot and upon which a beverage cup may be placed to receive the liquid dispensed from the spigot and a housing wall located between the spigot and cup support and behind a vertical line between the cup support and the spigot. An illuminated light bar is connected to the housing wall and extends along a vertical path between the spigot and the cup support so that a user can visualize the path of the liquid as it is dispensed from the spigot into a cup resting on or above the cup support. A plastic shield covers the light bar is also connected to the housing wall and extends along the path to shield the light bar from the liquid during use of drink dispenser.

In further variations, the cup alignment device may include a light bar having a plurality of LEDs in electrical communication with a timer and an electrical control circuit configured to sequentially and separately activate each LED. The drink dispenser may have a plurality of spigots with separate cup support below each spigot or a continuous cup support below a plurality of spigots, with a vertical light bar extending downward along the housing wall from each spigot toward the cup holder below that spigot.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other advantages and features of the invention will be better appreciated in view of the following drawings and descriptions in which like numbers refer to like parts throughout, and in which:

FIG. **1**A a top perspective view of a drink station on a support cabinet-stand that encloses a pressurized tank of carbon dioxide gas;

FIG. **1**B is a front view of a drink station on a support cabinet-stand of FIG. **1**A;

FIG. **1**C is a left side view of the drink station and cabinet-stand of FIG. **1**B;

FIG. **1**D is a back view of the drink station of FIG. **1**B;

FIG. **2**A is a diagram showing the fluid connections of the drink station, including the freezer system;

FIG. **2**B is a simplified plumbing diagram of FIG. **2**A, showing the fluid connections of the drink station with the freezer system removed;

FIG. **2**C is a simplified diagram of FIG. **2**B, showing a chilled water line only;

FIG. **2**D is a simplified diagram of FIG. **2**B, showing an alkaline water line with the chiller water line;

FIG. 2E is a simplified diagram of FIG. 2B, showing a carbonated water line using a carbonation mechanism;

FIG. 2F is the same plumbing diagram of FIG. 2B, showing a drink station that contains inside its housing a smaller carbon dioxide gas tank or canister and a small water filter with a leak stopper system;

FIG. 2G is a simplified diagram of FIG. 2B, showing a hot water line;

FIG. 3A is a perspective view showing portions of the freezer system of FIGS. 2A and 2F;

FIG. 3B is a perspective view showing a drinking water chiller coil and two in-line carbonator chambers;

FIG. 3C is a top view of the drinking water chiller coil and carbonators of FIG. 3B;

FIG. 3D is a perspective view of fluid lines and connections in the water drinking water chiller coil and the two carbonators shown in FIGS. 3B-3C;

FIG. 4A is a schematic sectional view of the chilled water reservoir showing its contents, including two agitators and the circulation of the water-bath inside the chilled water reservoir which has a spiral-wound, drinking water chiller coil;

FIG. 4B is a top view of a chilled water reservoir showing its contents, including a single agitator pump with an outlet tube in a water bath inside the chilled water reservoir which has a vertically-undulating drinking water chiller coil arranged in a rectangular shape with the coil's sides parallel to the water reservoir sides;

FIG. 4C is a sectional view taken along section 4C-4C of FIG. 4B showing the single agitator in an outlet tube and the resulting circulation path of the water-bath inside the chilled water reservoir;

FIG. 4D is an enlarged, exploded view of the single agitator inside an outlet tube;

FIG. 4E is a perspective view of a partial section of the water bath, water chilling coils and agitator of FIGS. 4B and 4C;

FIG. 5 is a sectional view along the longitudinal axis of an alkaline cartridge and mating manifold;

FIG. 6A is a cross-sectional view of the hot water tank of FIG. 6C, taken along section 6A-6A of FIG. 6C;

FIG. 6B is a cross-sectional view of a hot water tank of FIG. 6C, taken along section 6B-6B of FIG. 6C;

FIG. 6C is a perspective view of a hot water tank;

FIG. 7A is an exploded perspective view of a carbonator chamber that increases carbonation;

FIG. 7B is a sectional view of a first embodiment of a carbonator system using two carbonators;

FIG. 7C is a sectional view of an alternative embodiment of a carbonator system using two carbonators;

FIG. 8A is a front view of the drink station with a different number of dispensing buttons and with an optional cup alignment mechanism;

FIG. 8B is a front view of the drink station with a different number of dispensing buttons and plural spigots and with an optional cup alignment mechanism;

FIG. 9A is a perspective view of a figure eight evaporator coil;

FIG. 9B is a top view of the figure eight evaporator coil of FIG. 9A;

FIG. 9C is a sectional view taken along section 9C-9C of FIG. 9B;

FIG. 10A is a top view of an insulated chilled water reservoir containing a figure eight cooling coil an ice bank and two drinking water chiller coils, each with two carbonator chambers;

FIG. 10B is a sectional view taken along section 10B-10B of FIG. 10A;

FIG. 10C is a perspective view of a water booster reservoir;

FIG. 10D is a sectional view taken along section 10D-10D of FIG. 10C;

FIG. 10E is a top view of the insulated chiller water reservoir of FIG. 10A with two water booster reservoirs of FIG. 10C;

FIG. 10F is a sectional view taken along section 10F-10F of FIG. 10E;

FIG. 11A is a schematic illustration of a control circuit for the various components of the drink station;

FIG. 11B is a schematic illustration of a control circuit for providing chilled water;

FIG. 11C is a schematic illustration of a control circuit for providing alkaline water;

FIG. 11D is a schematic illustration of a control circuit for providing carbonated water; and

FIG. 11E is a schematic illustration of a control circuit for providing hot water.

DETAILED DESCRIPTION

As used herein, the relative terms upstream and downstream refer to the direction in which fluid flows through the various parts and fluid connections. The fluid generally flows downstream from the building water line, to the spigot, and upstream in the opposite direction.

As used herein, the following part numbers refer to the following parts: **20**—drink station; **22**—cabinet-stand; **24**—door; **26**—carbon dioxide gas tank; **28**—shut-off valve of the carbon-dioxide gas tank; **30**—carbon dioxide gas pressure and flow regulator; **32**—water filter; **40**—filling/dispensing area; **42**—sidewall of the dispensing area; **44**—spigot/nozzle; **46**—drain pan; **48**—drain grate; **50**—drain pipe; **51**—drain exit port; **52**—carbonated water button; **54**—alkaline water button; **56**—chilled water button; **58**—hot water button; **60**—auto-fill button; **62**—indicator lights; **64**—controller; **68**: dotted line simulating the housing of a drink station; **70**—compressor; **72**—freezer expansion line; **74**—chilled water reservoir; **76**—insulation; **77**—evaporator coil; **78**—condenser; **79**—fans; **80**—water pipeline; **82**—water pre-filter; **84**—water carbon-filter; **86**—water inlet port; **88**—flow meter; **90**—main valve; **92**—water delivery pump; **94**—drinking water chiller coil; **96**—chilled water valve; **97**—chilled water electrical communication line; **98**—chilled water line; **99**—water drain outlet on drink station housing; **100**—ambient water valve; **102**—alkaline cartridge; **104**—alkaline water line; **105**—alkaline water electrical communication line; **108**—internal carbon dioxide canister; **110**—carbon dioxide gas inlet port; **112**—carbon dioxide gas valve; **113**—carbon dioxide gas electrical communication line; **114**—carbon dioxide gas line; **116**—carbonated water valve; **118**—first splitter; **119**—second splitter; **120**—carbonator device; **121**—second carbonator device; **122**—carbonated water line; **124**_a, b_—check valves; **126**—drain line in chilled water reservoir; **130**—internal water filter; **132**—chilling water coil splitter; **134**—first carbonation water line; **138**—second carbonation water line; **140**—first connector gas-liquid; **142**—second connector gas-liquid; **144**_a, b_—venturis; **146**—main power switch; **147**—filter reset button; **148**—power reset button; **150**—hot water valve; **152**—hot water tank; **154**—heater; **156**—temperature sensor; **158**—thermistor; **160**—hot water line; **162**—vapor line; **163**—heater electrical communication line; **164**—hot water off switch; **166** child safety switch;

170—agitator pump; **171**—electrical motor; **172**—intake port; **174**—outlet openings; **175**—agitator pump electrical communication line; **178**—ice bank; **180**—ice temperature sensor; **182**—drinking water temperature sensor; **183**—temperature sensor electrical communication line; **186**—outlet tube; **188**—water level sensor; **190**—float; **192**—shaft; **194**—water level; **196**—chilled water reservoir filling valve; **198**—filling line; **200**—capillary tube; **202**—dryer; **204**—main power inlet electrical connection; **206** transformer; **210**—alkaline cartridge housing; **212**—cartridge cap; **214**—inlet; **216**—outlet; **218**—cammed mounting lugs; **220**—nozzle of the alkaline cartridge; **222**—inlet disk; **224**—bed of alkaline material; **226**—filter membrane; **228**—bed of activated charcoal; **230**—outlet disk; **232**—bottom of cartridge; **234**—central tube; **240**—manifold; **242**—door of the drink station; **244**—manifold inlet port; **246**—manifold outlet port; **248**—manifold cartridge inlet; **250**—manifold cartridge outlet; **260**—hot tank's housing; **261**—insulation; **262**—hot water reservoir; **264**—vapor chamber; **274**—dividing wall; **276**—control tube; **278**—slotted end; **280**—slots opening; **282**—vent opening; **284**—restrictor opening; **286**—seating recess; **288**—vent tube; **290**—water inlet; **292**—deflector; **294**—hot water drain fitting; **296**—mounting bracket; **298**—hot water tank drain on the drink station housing; **322**—first chamber input port; **324**—first chamber output port; **325**—first glass beads; **326**—second chamber input port; **327**—cartridge; **328**—second chamber output port; **329**—base; **333**—glass beads second chamber; **334**—first micromesh net; **336**—second micromesh net; **350**—drink alignment; **352**—light bar; **354** drink cup; **356**—LED; **401**—figure eight evaporator coil; **402**—first tubular coil; **402***a*—first side of coil **402**; **402***b*—opposing side of coil **402**; **402***c*—joining side of coil **402**; **402***d*—connecting segment of coil **402**; **404**—second tubular freezer coil; **404***a*—first side of coil **404**; **404***b*—opposing side of coil **404**; **404***c*—joining side of coil **404**; **404***d*—connecting segment of coil **404**; **406**—water reservoir; **408***a*—first reservoir side wall; **408***b*—second reservoir side wall; **408***c*—first reservoir end wall; **408***d*—second reservoir end wall; **408***e*—bottom reservoir wall; **410**—insulation; **411***a*—inlet; **411***b*—outlet; **412**—first chilled water reservoir; **414**—second chilled water reservoir; **416**—wall ice bank; **418**—center ice bank; **419**—outlet of water booster reservoir; **420**—inlet of water booster reservoir; **422**—first drinking water chiller coil; **424**—second drinking water chiller coil; **426**—water inlet valve; **428**—leak detector.

As used herein, the relative directions above and below, top and bottom, upstream and downstream are with respect to the vertical direction when the container shown in FIGS. **1** and **2** rests on a horizontal surface. Thus, the opening in the top of the container is above the closed bottom of the container and that opening is upstream of the container's bottom as fluid flows downstream from the top to the bottom. The relative directions inner and outer, inward and outward are with respect to the longitudinal axis of the container. Thus, the container's sidewall is outward of the container's longitudinal axis. As used herein, a majority refers to over 50%, a substantial majority refers to over 80% and substantially all refers to 95% or more. As used herein, "fluid" includes gases dissolved in or carried in liquid.

Referring to FIGS. **1A-1C**, a drink station **20** is shown placed on top of a cabinet-stand **22** with door **24**. The cabinet-stand has legs that rest on a floor. The cabinet-stand **22** encloses a carbon dioxide tank **26** having on/off (or open/closed) valve **28** and a carbon dioxide gas pressure and flow regulator **30**. Water filters **32** are located inside the cabinet/stand **22** and behind the carbon dioxide gas tank **26**. The gas tank **26** and water filter **32** are in fluid communication with the drink station **20** as described later.

The drink station **20** has a filling/dispensing area **40** that is preferably recessed into a front side of the drink station. The filling area **40** has a top and bottom joined by a sidewall **42** that is typically vertical. A dispensing outlet, referred to as spigot (or nozzle) **44** for convenience (but not by way of limitation), is at the top of the filling area and a drain pan **46** at the bottom of the filling area. The drain pan **46** takes the form of a container with an open top over which a drain grate **48** is removably placed. The drain pan **46** is in fluid communication with a drain line during use, typically by a drainpipe **50** (FIG. **1**D), connected to the bottom of pan **46**. The drain pipe **50** is attached to the base plate of the drink station and has a connection **51** where a removable drain tube can be connected in fluid communication with a building drain line.

Above the top of the filling area **40** are a plurality of pushbuttons or touch-buttons in electrical communication with internal components described later that result in dispensing different beverages from the spigot **44** of the drink station. The depicted embodiment has push or touch button **52** for dispensing carbonated water, button **54** for dispensing alkaline water, button **56** for dispensing chilled water, button **58** for dispensing hot water, and button **60**, the auto-fill button, for automatically filling a pre-determined volume (a calibrated quality) of water on a cup, bottle or container from the drink station. One or more indicator lights **62** may be provided to provide a visual indication related to the fluid being dispensed through the spigot, such as whether the water is hot, the water filter lifespan is terminated and other usage information. The touch buttons may be physically movable and displaceable buttons to send activating signals, or touch screen buttons using contact between two adjacent sheets to send activating signals, or other types of buttons that send signals when pressed.

The electrical communication of each dispenser button or activator **52**, **54**, **56**, **58**, **60** with the component or components used to dispense the selected type of beverage, is achieved through electrical communication with a controller **64**, whose functioning is later described in FIGS. **11**A through **11**E, which may be implemented by one or more printed circuit boards with electrical control circuits. The electrical communications are preferably communicated through insulated and grounded electrical wires. The controller **64** is also referred to herein as control module **64**.

Referring to FIGS. **2**A-**2**C, dispensing chilled water is discussed first. FIGS. **2**A-**2**B show the various fluid connections for dispensing the various types of water from the spigot **44**, with FIG. **2**B simplified so it does not show the refrigeration or freezer unit that chills the water, and with FIG. **2**C showing those fluid connections related to dispensing chilled water from the spigot. The dashed line **68** enclosing portions of FIGS. **2**A-**2**B indicate those fluid connections and components contained inside the drink station **20**.

A compressor **70** compresses any suitable refrigerant to create a cold fluid for the refrigeration system that freezes a portion of the water-bath inside a reservoir. The refrigerants are usually rapidly expanded through a nozzle to reduce the temperature of the expanding refrigerant that passes through the freezer expansion line **72**. The refrigerant line **72** may pass into and out of the chilled water reservoir **74** through sealed openings located at the top of the chilled water reservoir that are conceived in such a way as to prevent the passage of the water-bath from inside the reservoir and prevent any spillage if the drink station is moved. The chilled water reservoir **74** is typically a watertight, container defining a volume that is filled with a suitable fluid such as water that forms an ice-bank. The chilled water reservoir **74** advantageously has insulation **76** placed over the various laterally located sides or walls, top lid or cover, and bottom, of the chilled water reservoir **74**.

The chilled water reservoir **74** is sealed in order to reduce heat-dispersion and increase its efficiency, it forms a fluid tight container and does not have a lid or cover that may be readily removed without at least unfastening a plurality of threaded fasteners. A cover with star drive fasteners holding the cover to the reservoir body may be used, or the reservoir may be permanently sealed. The freezer expansion line **72** typically forms a serpentine path around the inner walls of the reservoir creating an evaporator coil **77**—to increase the heat transfer from the cold freezer lines to the walls of the reservoir and freeze the water bath in contact with the coils of the evaporator coil **77**.

After passing through the chilled water reservoir, the refrigerant in the freezer line **72** enters the suction line and then is compressed by the compressor **70**, after being compressed and returning to its liquid form, it passes through the condenser **78** which typically has one or more fans **79** blowing cooling air over the condenser **78**.

The freezer expansion line **72** freezes a portion of the water in the chilled water reservoir **74** forming an ice-bank in proximity of the evaporator coil **77** and maintains the remainder of the liquid water in the reservoir (the water-bath) at a temperature that is preferably near, but above freezing so that the water bath in the reservoir does not freeze solid. The chilled water inside the chilled water reservoir **74** may be circulated to reduce localized freezing and to improve chilling as described later. Stirrers, water jets, moving paddles or rotating propeller-type blades may be used to circulate the water-bath in the chilled water reservoir.

Referring to FIGS. **2A-2C**, the fluid path for dispensing chilled water is shown. A source of water, preferably a municipal water line connection **80** is reflected in the figures by a representative faucet. The source of line water **80** is in fluid communication through various tubes and pipes known in the art, with a prefilter **82** removing selected impurities of predetermined particle size or other content, from the water, and a water carbon-filter **84** removing further impurities, often impurities affecting taste. Any type of pre-filter **82** or water filter **84** may be used. Activated carbon filter media may be used in either filter **82** or **84**. The specific tubing or pipes placing the various components in fluid communication are not described in detail herein as such tubing, pipes and fluid tight connections are known in the art. As reflected in FIG. **2A**, the prefilter **82** and filter **84** may advantageously located outside of the drink station **20**. The filters are typically located inside the cabinet-stand **22** so they are adjacent the drink station.

Referring further to FIGS. **2C**, **1C** and **1D** the filtered water is placed in fluid communication with a water inlet port **86** on the drink station **20**, at the back of the drink station. A flow meter **88** is in fluid communication with the water inlet port **86** and located upstream of any other fluid connections and immediately downstream of the water inlet port **86**. But the flow meter could be located elsewhere, and for example could be located at or immediately upstream of the spigot **44**. Moreover, the flow meter may be any type of flow meter, but the meter is in electrical communication with the controller **64** to monitor the volume of water passing into and being dispensed by, the drink station. The flow meter **88** is placed in fluid communication with a main valve **90** that can open or close to regulate fluid flow through the drink station. The main valve **90** is preferably a normally closed valve that blocks fluid flow through the valve and opens only when beverages are dispensed. The main valve **90** is in fluid communication with a water delivery pump **92** which pumps water to a drinking water chiller coil **94** immersed in the water-bath inside the chilled water reservoir **74**. The chiller coil **94** lowers the temperature of the drinking water, but advantageously does not freeze the drinking water in the chiller coil as that could clog the coil preventing the drinking water to be dispensed. The drinking water chiller coil **94** is typically of stainless steel to reduce oxidation, scale buildup and avoid contamination. The downstream end of the drinking water chiller coil **94** is in fluid communication with a chilled water valve **96** that regulates the flow of chilled water to the spigot **44** through chilled water line **98**. The chilled water valve **96** is preferably a normally closed valve. The chilled water valve **96** is normally in a closed position to block fluid flow through the valve. Advantageously, as shown in FIG. **2C**, the chilled water valve **96**, the main valve **90**, the delivery pump **92** and chilled water button **56** are in electrical communication to open the valve **90** and **96**, power the delivery pump **92** and dispense chilled water from the spigot **44**. Therefore, the chilled water valve **96**, main valve **90**, delivery pump **92** and chilled water button **56** are in electrical communication with controller **64** through electrical communication lines **97** (FIG. **2C**), to control the opening and closing of the appropriate valves to dispense chilled water from the spigot **44**.

A cold water drain line is in fluid communication with drain in the bottom of the chilled water reservoir, which is in fluid communication with a cold water drain outlet **99** (FIG. **1D**, **2A**, **2B**) to allow the chilled water reservoir **74** to be emptied of water for cleaning, maintenance, moving the drink station or other reasons. The cold water drain outlet **99** is shown as located on the back of the drink station **20** but other locations could be used.

The flow meter **88** measures the volume of fluid or water entering the drink station and sends signals reflective of that information to the control module **64**. The main valve **90** can stop or allow all flow through the fluid chilled water button **56** on the drink station. The delivery pump **92** pressurizes the fluid lines so water flows through the fluid lines depending on which valves are opened or closed in various combinations. The water delivery pump **92** pumps or forces water at a predetermined pump pressure through various fluid lines of the drink station, including through the drinking water chiller coil **94**, while the chilled water valve **96** regulates the flow of chilled (and filtered) water through the spigot **44**. The chilled water valve **96** is actuated by various means, including electrical, pneumatic, or mechanical. Preferably, the chilled water valve **96** is an electrically actuated valve in electrical communication with the button **56** so that a user may press the button and the chilled water valve **96** will open to dispense chilled water to the spigot **44** for as long as the button maintains electrical communication, or for a predetermined time interval determined by an electrical circuit, or until a weight sensor or a proximity sensor, or a volume level sensor positioned below the drink container to send a shut-off signal when the sensor indicates the weight reaches a predetermined level or the sensor reaches a termination level, or a proximity position.

Referring to FIGS. **2A**, **2B** and **2D**, the fluid paths and parts are disclosed for dispensing alkaline water when the alkaline button **54** is pressed. Water flows from the line source **80**, through filters **82**, **84** and inlet port **86** and flow meter **88** and main valve **90**, to an ambient water control valve **100**. The valve **100** is preferably a normally closed, ambient water valve **100** that passes the filtered line water to an alkaline cartridge **102** which is in fluid communication with the spigot through an alkaline water line **104**. The alkaline cartridge **102** makes the filter line water alkaline, by adding one or more dissolved alkaline minerals or electrolytes, including, but not limited to, calcium magnesium, potassium, manganese, iron, phosphorous, sodium and zinc or by otherwise raising the pH of the incoming drinking water to make the water less acidic, resulting in a pH between 7.2 and 10.5. The alkaline cartridge is described later regarding FIGS. **2**D and **5**. The fluid line out of the main valve **90** advantageously flows through one or more fluid splitters, preferably through a T intersection with a first fluid channel in fluid communication with the drinking water chiller coil **94**, and a second fluid channel in fluid communication with the ambient water valve **100** and the alkaline cartridge **102**.

Referring further to FIGS. **2**D, **11**A and **11**C, the ambient water valve **100** opens or closes so the filtered water at room temperature flows into and through the alkaline cartridge **102**. The ambient temperature water dissolves the alkaline minerals faster than does chilled water. The ambient water valve **100** may be actuated by various means, including electrical, pneumatic, or mechanical. Preferably, the ambient water valve **100** is an electrically actuated valve in electrical communication with the alkaline button **54** so that a user may press the button and the ambient water valve **100** will open to force ambient temperature water through the alkaline cartridge **102** and out the spigot **44** for as long as the button maintains electrical communication, or for a predetermined time interval determined by an electrical circuit, or until a weight sensor positioned below the drink container, or a volume level sensor or a proximity sensor to send a shut-off signal when the sensor indicates the level of the dispensed water reaches a predetermined weight threshold, or the sensor reaches a termination level, or proximity position.

Advantageously, the controller **64** opens both the ambient water valve **100** and the chilled water valve **96** so that both alkaline water and ambient temperature water are dispensed at the spigot at the same time. The relative time that the alkaline control valve **100** is left open or closed, compared to the relative time that the chilled water control valve **96** is left open or closed, with adjust both the temperature of the water dispensed by the spigot **44** and the amount of alkalinity. The addition of chilled water to the ambient alkaline water achieves cooler but less alkaline water than if only alkaline water was dispensed.

The ambient water valve **100** and the chilled water valve **96** and the main valve **90** and the alkaline activation button **54** are in electrical communication to open the appropriate valves and simultaneously dispense alkaline water and chilled water from the spigot **44**. The taste of alkaline water is believed improved if consumed below ambient temperature, and preferably if 6° F.-15° F. below room temperature, and more preferably served between 50° F.-70° F. Adding alkaline water to chilled water, or vice versa, may adjust the temperature as desired.

The ambient water valve **100** is in electrical communication with controller **64** through alkaline electrical communication line **105** (FIG. **2**D), to control the opening and closing of the appropriate valves to dispense chilled water from the spigot **44**, with the other described valves being in electrical communication through dedicated alkaline water lines or through chilled water electrical communication lines **97**. The controller **64** may contain a timer circuit to dispense relative amounts of alkaline water and chilled water to achieve a desired temperature based on the sensed temperature of the chilled water in the chilled water reservoir, and either the ambient temperature, or the sensed temperature of the alkaline water, or an assumed temperature of the alkaline water. Advantageously the pump **92** is not activated during dispensing of alkaline water so that the line pressure of the water source **80** forces water through the alkaline cartridge and out the alkaline line. But the pump **92** could be activated if desired, but preferably at a lower flow rate than used for chilled water, advantageously from 10% to 30% the flow rate used for dispensing chilled water. The various temperature sensors technically sense various parameters that may be directly or indirectly correlated with the temperature, rather than directly measuring or sensing the temperature itself. As used herein, references to detecting, measuring or sensing the temperature includes detecting, measuring or sensing parameters correlated with temperature.

In a further variation, the alkaline cartridge **102** may be omitted or bypassed in the manifold **240**, so that ambient temperature water flows through the ambient water valve **100**, and out what is normally the alkaline water line **104**, so as to dispense filtered, ambient temperature water at the spigot **44**. If the alkaline cartridge **102** and manifold **240** are omitted, then the alkaline water line **104** is more aptly referred to as an ambient water line.

Referring to FIGS. **2**B, **2**E, **11**A and **11**D, the fluid paths and parts are disclosed for dispensing carbonated or sparkling water when the carbonated water button **52** is pressed, with the carbonation added by carbon dioxide gas in a pressurized container **26**. As before, water flows from the line source **80**, through filters **82**, **84** and inlet port **86** and flow meter **88** and main valve **90**. The carbon dioxide gas tank **26** is in fluid communication with carbon dioxide inlet port **110** on the drink dispenser **20**, with the port preferably located on a back side of the drink station. The carbon dioxide inlet port **110** is in fluid communication with a carbon dioxide valve **112** located inside the drink station and in communication with the carbonated water button **52** to regulate the amount of carbon dioxide from canister **26** passing through the valve. The carbon dioxide valve **112** is a normally closed, valve in electrical communication with a controller **64** and the carbonated dispensing button **52** through carbon dioxide electrical communication line(s) **113** (FIG. **2**E). The carbon dioxide valve **112** is in fluid communication with a carbon dioxide chilling line **114** that passes through (into and out of) the insulation **76** on the wall of the chilled water reservoir **74** and through the chilled water inside the reservoir to place the carbon dioxide valve in fluid communication with a carbonation valve **116** that is also in fluid communication with the chilled water line. The carbonation valve **116** is a normally closed valve in electrical communication with a controller **64** to open and pass fluid to the spigot when the carbonation button **52** is pressed. The controller **64** is in electrical communication with the main valve **90** as previously described.

A first splitter **118** is upstream of the chilled water valve **96** (FIG. **2**E) and is in fluid communication with the carbonated water valve **116** to regulate the volume of chilled water that intersects with the chilling carbon dioxide gas line **114** at a second splitter connection **119**, such as a T-joint, to mix the chilled water and chilled carbon dioxide and preferably contains a venturi (not shown in FIG. **2**E) in the splitter to enhance the mixing of chilled water and chilled carbon dioxide. If the second splitter **119** does not contain an internal splitter, then a venturi preferably immediately follows downstream of the splitter **119**. The second splitter connection **119** is in fluid communication with one or more carbonators **120** and **121** that combine chilled water from line **116** with carbon dioxide gas from line **114** and, independently, carbonate the chilled water. The carbonator(s) **120** are described later. A carbonated water line **122** is in fluid communication with the carbonator(s) **120** and the spigot **44**. Advantageously, first and second check valves **124***a*, **124***b* are on opposing sides of the splitter **119**. The check valves **124** allow the chilled water and chilled carbon dioxide to pass in only one direction, downstream toward splitter **119** (FIG. **2**E) which has a mixing venturi in it. The splitters **118**, **119** are shown as located outside of the chilled water reservoir **74** but may be located inside the chilled water reservoir and inside the water-bath (as in FIGS. **2**A and **2**F).

The carbon dioxide gas valve **112** and carbonated water valve **116** regulate the amount of carbon dioxide gas and chilled water flowing to the carbonators **120** and **121** and out the carbonated water line **122** to the spigot **44**. The valves **112**, **116** may be actuated by various means, including electrical, pneumatic, or mechanical. Preferably, the valves **112**, **116** are electrically actuated and in electrical communication with the carbonation button **52** so that a user may press the button and the carbon dioxide gas valve **112** and carbonation valve **116** will open main valve **90** will open too and the water delivery pump **92** will be powered on to provide predetermined or adjustable volumes of chilled carbon dioxide gas and chilled water to the carbonators **120** and **121** which generate the sparkling or carbonated water flowing to the spigot **44** for as long as the button maintains electrical communication, or for a predetermined time interval determined by an electrical circuit, or until a weight sensor positioned below the drink container, or until a level sensor or proximity sensor sends a shut-off signal when the sensor indicates the weight reaches a predetermined level or the sensor reaches a termination level or a proximity position.

Referring to FIGS. **2**A, **2**F, **11**A and **11**D, alternative fluid paths and parts are disclosed for an alternate arrangement for dispensing carbonated or sparkling water when the carbonated water button **52** is pressed. The carbonation is added by carbon dioxide gas in a pressurized container, an internal carbon dioxide gas canister **108** located inside the drink station **20**, as shown in FIG. **2**F. Line water **80** is in fluid communication with water inlet port **86**, which is in fluid communication with one or more internal water filter(s) **130**. The filter(s) may be any type of water filter. The filtered water from filter(s) **130** is in fluid communication with flow meter **88** and main valve **90** and water delivery pump **92**. Pump **92** forces water through the drinking water chiller water coil **94** immersed in the water-bath inside chilled water reservoir **74**. The drinking water chiller coil **94** has a chilled coil splitter **132** that has a chilled water line **98** in fluid communication with chilled water valve **96** located downstream of the chilled water reservoir **74** to release water to the chilled water line **98** and spigot **44** as previously described in FIG. **2**C.

In addition (FIG. **2**F), the chilled coil splitter **132** has a first carbonated water line **134** in fluid communication with the carbonated water valve **116** that is located outside the chilled water reservoir **74**. The carbonated water valve **116** is in fluid communication with one or more carbonators **120** through a second carbonated water line **138**. After carbon dioxide gas from line **114** is mixed with chilled water from line **138** inside the carbonator(s) **120** and **121**, the resulting carbonated or sparkling water is flowing outside the chilled water reservoir **74** through carbonated water line **122**. The second carbonation line **138** interacts with the carbon dioxide gas chilling line **114** as described earlier regarding FIG. **2**E, but in a different configuration as shown in FIG. **2**F and described below.

In FIG. **2**F, the drink station **20** has an internal carbon dioxide gas tank or canister **108** with a carbon dioxide gas pressure and flow regulator **30**. The carbon dioxide canister **108** is in fluid communication with a carbon dioxide valve **112** which is in fluid communication with a carbon dioxide gas chilling line **114**, a portion of which is immersed in the water bath of the chilled water reservoir **74** as described earlier.

As seen in the enlarged portions of FIGS. **2**F and **3**C-**3**D, the carbon dioxide chilling line **114** and the second carbonation water line **138** containing chilled water are connected to each other by at least one, and preferably two connectors **140**, **142**, each connector extending from the carbon dioxide chilling line **114** to intersect with and connect to the second carbonation water line **138** that contains chilled water. A venturi **144**, also referred to herein as a static, venturi restriction device, is advantageously located in each of the connectors **140**, **142** at the juncture with the other line, and a venturi **144** is located in the second carbonation line **138** at the two junctures of the connectors **140**, **142**. Thus, in the enlarged portion of FIG. **2**F, a laterally extending connector **142** has a venturi **144***a* with the venturi downstream throat opening onto the vertically extending chilled water line **138**, and the chilled water line **138** has a venturi **144***b* with the venturi downstream throat exiting immediately adjacent but at right angles to the venturi **144***a* in the connector **142**. The second connector **140** has a similar construction.

The four venturis **144***a*, **144***b* intermix the chilled water and chilled carbon dioxide which exits out the downstream end of the first carbonation line **138** and is in fluid communication with the carbonator chambers **120** and **121**. Two venturi devices **144***b* are aligned with a fluid line in communication with the carbonators **120**, **121** while two venturi devices **144***a* are aligned perpendicular to that fluid line, and the outlet of each pair of venturi devices **144***a*, **144***b* are adjacent to each other and perpendicular to each other to achieve what is believed to be maximum intermixing. In some embodiments, only one venturi device is sufficient to accelerate the water from the second carbonated water line **138** and mix it with the carbon dioxide gas from line **114**: this is the venturi **144***b* located at juncture **142**. This venturi **144***b* located in the downstream of second carbonated water line **138** is believed to achieve superior intermixing of the carbon dioxide gas and chilled water and thus achieve improved carbonation. Orienting the juncture of the water line **138** and carbon dioxide line **114** at right angles to each other is believed to further improve the intermixing and further increase the carbonation of the water. Placing a venturi **144***a*, **144***b* at the two junctures **140** and **142** of the two lines and adjacent the other venturi is believed to further improve the intermixing and further increase the carbonation of the water.

While two sets of intersecting lines with the two connections **140** and **142** are shown and described, one set is believed sufficient. Carbonated water line **122** places the carbonator(s) **120**, **121** in fluid communication with the spigot **44** to dispense chilled, carbonated water upon activation of carbonated water button **52** as previously described. As seen in the enlarged portion of FIG. **2**F, a check valve **124***a*, **124***b* is placed in the carbon dioxide gas line (**114**) and in the second carbonation water line (**138**), respectively, in order to prevent backflow of fluids from the intermixing caused by the venturis **144**a and or **144**b.

Referring to FIGS. **2**A, **2**B and **2**G, the fluid paths and parts are disclosed for dispensing hot water when the hot water button **58** is pressed. As before, water flows from the line source **80**, through filters **82**, **84** and inlet port **86** and flow meter **88** and main valve **90**. The main valve **90** is placed in fluid communication with the pump **92** (not shown) and chilled water reservoir **74** (not shown). But the main valve **90** is also placed in fluid communication with a hot water valve **150** that controls the flow of ambient temperature water from main valve **90**, to a hot tank **152** having an electrical resistance heating element **154** and having temperature sensor and regulating mechanisms, which preferably include a negative temperature coefficient (NTC) sensor **156** (a thermistor) with a measuring water temperature to regulate hot water temperature in connection with a controller **64**, and backup temperature sensor **158** such as a thermostat to send a signal to the controller **64** that shuts off the heater if the temperature is too high, above a defined temperature threshold. The heater **154** thus heats the water in the hot water tank, with the temperature controlled by the NTC **156**, and appropriate circuitry in a controller **64** in electrical communication with the thermostat **158**, as a security shutoff of the heater if the temperature is too hot in case of malfunctioning of the NTC.

The hot water valve **150** is in fluid communication with hot water tank **152** that heats the water to a predetermined temperature and is in fluid communication with the spigot **44** through a hot water line **160** and through a vapor line **162**. Heated water flows to the spigot **44** through hot water line **160**. The vapor line **162** acts as a vent line to allow hot water to flow back to the hot water tank **152** after dispensing is finished so that a column or fluid line full of hot water is not in constant fluid contact with the spigot **44**, thus avoiding a spigot that is continually heated and hot. In addition, it avoids that a mass of hot water remains in line **160** when the dispenser is not in use and cools down over time. Therefore, the next user selecting hot water from the dispenser will first get the water remaining in line **160** that has cooled down and, therefore, when dispensed, this portion of remaining water in line **160** would reduce the temperature of the hot water dispensed at the spigot. The vent line **162** avoids this undesirable possibility. A further description of the hot tank **152** and construction is provided later.

The hot water valve **150** regulates the amount of water flowing to the hot water tank **152** and ultimately the volume of water available to flow out of the spigot **44**. The hot water valve **150** may be actuated by various means, including electrical, pneumatic, or mechanical. Preferably, the hot water valve **150** is electrically actuated and in electrical communication with the hot water button **58** so that a user may press the button and the hot water valve **150** will open to provide predetermined or adjustable volumes of hot water to the spigot **44** for as long as the button maintains electrical communication, or for a predetermined time interval determined by an electrical circuit, or until a weight sensor positioned below the drink container, or a volume level sensor, or a proximity sensor, to send a shut-off signal when the sensor indicates the weight reaches a predetermined level or the sensor reaches a termination level, or a proximity position.

Referring further to FIGS. **2**G, **11**A and **11**E, thermostat **158**, thermistor **156**, heater **154**, hot water button **58**, and hot water valve **150** are in electrical communication to open the valve **150**, together with main valve **90**, and dispense hot water from the spigot **44** when the button **58** is activated, and to regulate the temperature of the water and prevent excessively hot water or damage to the heater tank **152**. Advantageously, these electrical communications are through various heater electrical line(s) **163** (FIG. **2**G) dedicated to each sensor, thermistor, thermostat, heater and the **2** valves involved in dispensing hot water of any temperature. A hot water off switch is also provided so that if the hot water is not expected to be used for an extended length of time, the hot water heater **154** may be shut off to conserve energy. Further, a child safety switch **166** may be provided (FIG. **1**D), which leaves the hot water heater **154** powered and hot water available but disables to the hot water valve **150** (FIG. **2**G) so a child may not accidentally dispense hot water. An adult may switch the child safety switch **166** off to dispense hot water using the hot water button **58** and switch the child safety switch back on the desired hot water is dispensed. Alternatively, a software code is provided, when touching a sequence of buttons in a certain way, although child safety switch may be enabled (or engaged), the code allows for a temporary bypass of the child safety switch and dispense, only one-time, hot water. The code reduces the problem of disengaging the child safety switch and then forgetting to re-engaging it back after hot water is dispensed. The hot water off switch **164** and the child safety switch **166** are in electrical communication with the controller **64** through separate electrical lines that are not shown. The child safety switch **166** and hot water off switch **164** are shown as located on the back of the drink station **20**, (see FIG. **1**D), but other locations on the drink station could be used. Moreover, an indicator light **62** may be provided to indicate whether or not the water is available, or the child safety switch is enabled. A red indicator light **62** is believed suitable to indicate hot water is available. When the hot water light **62** is off, it also indicates the child safety is enabled. When the light is on, the child safety is disabled, and hot water may be dispensed.

Referring to FIGS. **2**A, **2**F and **4**A, configurations including one or two agitator pumps **170** are shown. Each agitator pump **170** is believed to improve the convection coefficient between the ice-bank and the water-bath more than commonly used stirrers, water jets, moving paddles or rotating propeller-type blades. Agitator pumps have the advantage of being submersible, can take water from a specific direction—intake flow—and direct water to another specific direction—outflow. In particular, agitator pumps can be positioned in a way to take water in proximity of the drinking water chiller coil **94** and direct outflow water towards the ice-bank walls and the evaporator coils. A submersible agitator pump is designed that can direct outflow so as to avoid directing water towards temperature sensors.

An agitator pump, preferably contains a submersible agitator electrical motor **171** (FIG. **4**A) that intakes water through an axial port or opening **172** which is preferably, but optionally, a nozzle, and expels water out outward a series of radial outlet ports or openings **174**. The number of radial openings may differ, but it is believed that at least four openings are necessary, each of them directing the outflow of water valves that direct outflow of water towards one of the four walls of the chilled water reservoir against which the ice-bank wall is formed. The first port, the intake port, **172** thus has a flow path along the longitudinal axis of the drinking water chiller coil **94**, while second outlet ports or outlet openings **174**, create a flow path outward from that axis (see FIG. **4**A). The two intake ports or nozzles **172** of the two agitators **170** in FIG. **4**A advantageously extend along the longitudinal axis of the drinking water chiller coil

94 and face each other so that flow path of chilled water enters into the nozzle extends along and parallel to the axis extending between the nozzles and the longitudinal axis of the chiller coil **94**. The two opposing agitators **170** circulate the water-bath inside the chilled water reservoir **74** and move the chilled water from the drinking water chiller coil to the ice-bank **178** and back towards the drinking water chiller coil **94**, thereby allowing heat-exchange between the ice and the drinking water by forced thermal convection. The two agitators **170** are advantageously directly opposite each other and aligned along a vertical axis, with the inlet ports **172** forming intake nozzles. The intake nozzles **172** suck water along the central axis of the reservoir and the central axis of the drinking water chiller water coil **94**, where the temperature of the water in the water bath is higher, while both agitator pumps expel water outward through various round openings or ports **174** and away from the longitudinal axis of the drinking water chiller coil **94**, and preferably expels the water radially out of ports or openings **174** and towards the ice-bank. The flow paths of the agitator pumps, inlet ports **172** and outlet openings **174** advantageously create a spherical flow pattern circling outward from the longitudinal axis of the drinking water coil, toward and past the drinking water chiller coil **94**, upward toward the middle of the reservoir, and then inward and back toward the nozzle of the same pump that expelled the water. Each agitator pump **170** advantageously creates a circulating spherical flow that is extends about midway between the two agitators **170** with the flow paths shown in FIG. **4**A by arrows. Other flow paths may be created by angling the agitators **170** differently.

The agitators **170** are responsible of enhancing the heat exchange between the ice-bank and the water-bath inside the chilled water reservoir. The water in the reservoir is kept just above freezing. The thickness of the ice-bank **178** and, in general the amount of ice formed around the evaporator coil inside the chilled water reservoir is controlled by the NTC **180** in FIG. **4**A. The ice-bank, when it melts during the heat-exchange process with the water-bath provides the system the necessary latent heat and act as a heat sink to maintain the water temperature low during periods of high demand. The ice **178** forms around the evaporator coil **77** which usually follows a serpentine path over the inner surface of the water reservoir sidewalls, so the walls of an ice bank **178** extend inward from the evaporator coil **77**, while the top and bottom of the water reservoir are typically not frozen. Over time, the ice banks **178** extend inward toward the center of the chilled water reservoir **74** and away from the walls of the reservoir, to form the ice bank **178** encircling the vertical and cylindrical arrangement of the drinking water chiller coil **94**. The refrigeration circuit and agitators **170** are operated and controlled so the ice bank **178** thickness does not encase the various fluid tubes and connections inside the drinking water chiller coil **94** and does not freeze the fluids inside those fluid tubes and connections.

Prior art drink stations use agitators **170** that are activated for predetermined periods of time after liquid is dispensed from the spigot, or simply based on the ice-bank **178** growth. Advantageously, the operation of the agitators **170** is controlled based on the temperature of drinking water chiller coil measured in the water-bath adjacent to the drinking water chiller coil **94**. To measure the drinking water temperature a second NTC thermistor **182** is used. Referring to FIG. **4**A, the chilled water reservoir has a first temperature sensor **180** (NTC) located at a predetermined distance from the evaporator coil **77** to regulate ice thickness, and has, at least, one second temperature sensor **182** (NTC) that is located on the external surface and is tightly attached or connected to the drinking water chiller coil **94**. The sensor **182** is the drinking water temperature sensor and advantageously measures the temperature at or adjacent to the drinking water chiller coil **94**. For more accurate temperature measurement of the drinking water chiller coil an in-line temperature sensor may be located directly inside the drinking water chiller coil itself. As used for these temperature measurements in the chilled water reservoir **74**, the temperature "adjacent" an object means the temperature within 5 mm of the object and the various sub-ranges.

The second temperature sensor **182** is advantageously an NTC sensor having an electrical resistance that decreases as temperature increases, but other sensor types could be used. When the water temperature approaches freezing at the location of the drinking water chiller coil **94** as detected by the drinking water temperature sensor **182**, the electrical power to the agitator electrical motor **171** is shut off so the agitators **170** stop circulating water inside the chilled water reservoir **74**. Controlling the operation of the agitators **170** is believed unusual and advantageous, as it stops circulation of the chilled water and thus stops carrying heat away from the drinking water chiller coil **94**, preventing freezing of the drinking water that must flow inside the drinking water chiller coil **94**. At the same time, if the agitators **170** continue working, they will gradually reduce the thickness of the ice-bank when dispenser is not in use.

The first temperature sensor **180** inside the chilled water reservoir **74**, also called the ice temperature sensor **180**, is located parallel to the wall of the chilled water reservoir **74** and spaced a predetermined distance from the wall and from the evaporator coil **77** in a position as to allow ice to grow around the evaporator coil, but stop the refrigeration by powering off the freezer's compressor **70** electrically connected to the controller **64** (see FIG. **11**A), when the ice-bank thickness reaches the ice temperature sensor **180**. The ice temperature sensor **180** is located so that its outward facing surface that faces the evaporator coil **77** is at the desired wall thickness for the ice bank **178**. When ice accumulates on the inside wall of the reservoir **74** and evaporator coil **77**, the ice will increase in thickness by freezing the chilled water-bath in proximity of the evaporator coil, inside the chilled water reservoir **94**. When the ice bank **178** expands and contacts the ice temperature sensor **180**, the sensed temperature is freezing (32° F. or 0° C. or below) and the ice temperature sensor **180** sends an electrical signal to controller **64** which results in the power to the refrigeration system compressor **70** and fans **79** being shut off so that active cooling of the refrigerant in the freezer expansion line **72** stops and the evaporator coil stops freezing the water-bath around its coils. The fans **79** for the heat exchanger are also shut off. The shut-off temperature can be varied, as long as the temperature is correlated to a desired thickness of the ice bank **178**, or to a desired volume of ice in the ice bank **178**. The shutoff temperature is right below) 0° C. (corresponding to the freezing temperature of the water at atmospheric pressure). The range within which NTC **180** preferably works is between −3.0° C. and +1.0° C. In an interval of temperatures between −3.0° C. and −0.5° C. the refrigeration system (compressor **70** and fans **79**) are powered off by the controller **64** which receives the temperature information from the NTC **180**. Instead, in a temperature range between 0.1° C. and 2.0° C. the controller **64** activates the refrigeration system (by powering on both the compressor **70** and the fans **79**), thus allowing new ice to be formed around the evaporator coil **77**. Depending on the routing of the evaporator coil **77**, the size, shape and location of the ice bank **178** may vary, but the freezer expansion line **72** and the evaporator coil **77** are designed to produce a uniform thickness of ice over a known area so that the melting of the ice can be predicted, and so that the thermal balance between the ice and the temperature of the water-bath inside the reservoir **74** can be predicted.

The agitator electrical motor(s) **171** is/are in electrical communication with controller **64** through the agitator electrical communication line **175** (FIG. **4**A). The drinking water temperature sensor **182** and ice temperature sensor **180** are also in electrical communication with controller **64** through temperature sensor electrical communication lines **183**. The controller **64** contains circuitry to independently and separately control both the ice-bank thickness and operate the refrigerator system (compressor **70** and fans **79**), and the drinking water temperature in the drinking water chiller coil **94**, by operating (powering on or off) the agitator(s) **170**.

The drinking water temperature sensor **182** which is positioned adjacent or inside the drinking water chiller coil **94** measure the temperature of the drinking water inside the coil **94** either directly (if inside) or indirectly by way of calculating the conductivity coefficient of the stainless steel which is the material the water chiller coil's walls are made of. At a water temperature above a certain threshold water temperature called Lower Temperature Point (LTP) (which is a temperature between 0.01° C. and 1.5° C., preferably between 0.1° C. and 1.1° C. and in particular preferably right at 0.6° C.) the agitator(s) operates. At a water temperature below a certain threshold temperature called Upper Temperature Point (UTP) (between 0.3° C. and 3.0° C., preferably between 0.7° C. and 1.7° C. and in particular preferably right on 1.2° C.) the agitator(s) **170** are powered off by the controller **64**. Therefore, preferably, above the LTP the agitator(s) **170** work, below the UTP the agitator(s) **170** do not work; this is believed to avoid consuming latent heat from the ice-bank without this latent heat being efficiently used to lower the temperature of the drinking water. In the range of temperatures between LTP and UTP, called the ear-band, the agitator(s) do not work if they were not working and continue not to work until the temperature of the drinking water inside the chiller coil **94** reaches the UTP at which point the agitator(s) receive a signal to start working. The agitator pump will continue to work until the temperature of the drinking water goes back down. In this process when the temperature decreases from a temperature above the UTP, the agitator(s) **170** will continue to work until the LTP is reached. At this point the controller **64** shuts off the agitator(s). In summary, below LTP the agitator(s) do not work. Above the UTP the agitator(s) work. In the ear-band of temperatures between the LTP and the TP, the agitator(s) will continue to work if they were working before (because the drinking water temperature was above the UTP), while the agitator(s) will continue to idle if they were not working before (because the drinking water temperature was below the LTP). In the range of temperatures between UTP and LTP the agitator(s) remain in its pre-existing working or non-working conditions.

In another variation, the agitator speed varies depending on the drinking water temperatures. The speed of the agitator increases as the temperature increases. Below the LTP the agitator(s) do not work. Above the LTP agitator starts working at a speed that is proportional to the rising of the temperature of the drinking water inside the chiller coil as detected by temperature sensor **182**. The speed variation of agitator's electric motor **171** is controlled by the controller **64**.

Referring to FIG. **4**A, other embodiments use two agitator pumps **170** and, while both agitator pumps work above UTP and neither of the two agitator pumps work below LTP and have only one agitator pump working in the range of temperatures between UTP and LTP.

Referring to FIGS. **4**B-**4**E, the outlet openings **174** of one or more of the agitator pumps **170** may have an outlet tube **186** to direct the flow from the outlet ports **174** to avoid directly impinging on one or more of the temperature sensors (e.g., **180**, **182**) in the chilled water reservoir **74**. The depicted agitator pump **170** is shown as a cylindrical tube with four hollow fins which form four outlet tubes **186**. Each outlet tube **186** extends outward from the rotational axis at an inclined angle to the outer periphery of the cylindrical tube so that two pairs of substantially parallel fins or outlet tubes **186** are provided which results in an outlet opening every 90°, each directed toward one of the walls of the chilled water reservoir **74**. The four fins or outlet tubes **186** are hollow and open into the hollow interior of the pump housing. Each of the four fins or outlet tubes **186** has a rectangular cross-section, but other cross-sectional shapes could be used.

The rotor of the agitator pump (FIG. **4**E) is depicted as having four curved flutes equally spaced about a rotating drive shaft, with the curved flutes fitting inside the cylindrical housing. The agitator shaft and rotor rotates at high speed (at least 3,000 rpm) so that the water from the chilled water-bath is sucked in from the bottom of the agitator pump through the vertically oriented intake port **172** and is forced out through the outlet openings **174**, after being accelerated by the turbo-propeller shaped rotor of the agitator pump **170**. The chilled water passes through each of the four fins or outlet tubes **186** as shown by the arrows indicating water inlet and outlets in FIG. **4**D. The four fins or outlet tubes **186** in turn are arranged to direct the flow of water outward and in a plane orthogonal to the longitudinal axis of the drinking water drinking water chiller coil **94** and parallel to the vertically undulating, drinking water drinking water chiller coil **94**. The water circulation path established by the outlet tubes **186** and the shape of the reservoir **74** a path that does not cause the water from the outlet tubes **186** to flow directly against one of the temperature sensors (e.g., **180**, **182**) and instead the flow path impacts a portion of the ice bank **178** or evaporator coil **77** around which the ice bank forms, before eventually reaching the vicinity of a temperature sensor.

Four fins or outlet tubes **186** are shown in FIGS. **4**B through **4**E, a configuration used to advantage in the event that there are four chilled water temperature sensors (e.g., NTC sensors **180**, **182**) with one sensor adjacent each corner of a chilled water reservoir having a square cross-section, so each of the four fins or four outlet tubes can be directed toward the middle of the space between each pair of adjacent temperature sensors. This arrangement works especially well, when the drinking water chiller coil **94** has vertically oriented, undulating coils as in FIGS. **4**B, **4**C, **4**D, and **4**E, rather than generally horizontal oriented coils as in FIGS. **3**B, **3**C and **4**A and especially where the coils **94** have spaces through which the fins or outlet tubes may end or even protrude as shown in the figures. The water expelled in the four directions can therefore easily pass through the vertically oriented coils of the drinking water chiller coil **94** and directly hit the four walls of the chilled water reservoir **74** where the ice-bank **178** grows around the evaporator coil **77**.

A single agitator pump is shown with four fins or outlet tubes **186**, one aimed for the middle of each wall of the rectangular reservoir **74** and the ice bank **178** associated with each wall and between each pair of temperature sensors (e.g., **180**, **182**). While a single agitator pump is shown in FIGS. **4**B-**4**E, a pair of agitator pumps, each with outlet tubes **186** may be used as in FIG. **4**A. One or more of the outlet ports **174** of FIG. **4**A could each have an outlet tube **186** on them with the outlet tubes being cylindrical in shape to mate with the depicted circular outlet openings shown in FIG. **4**A, or the outlet tubes **186** could have a circular passage that transitions to a rectangular shaped exit.

Referring to FIGS. **2**A, **2**F and **4**A, a filling flow path for the water inside the chilled water reservoir **74** is described. A water level sensor **188** (FIG. **4**A) is connected to the reservoir to measure the water level inside the reservoir. The water level sensor **188** is preferably connected to the top of the reservoir but could be mounted off of the reservoir sides or components enclosed in the reservoir. The depicted water level sensor **188** has a shaft **192** extending downward a distance sufficient, so that a float **190** that is slidable on the shaft can move upward and downward. As the water level **194** (FIG. **4**A) rises or falls, the float **190** moves up and down. When the water level **194** is below a predetermined level, an electrical signal is sent by the water level sensor **190** to a controller **64** that actuates opens a valve **96** to add water to the inside of the chilled water reservoir **74**. Instead of a vertical moving float **190**, a lever extending generally horizontally and having a float on its end cold be used. Other water level sensors are known in the art and could also be used to signal when the water level **194** inside the reservoir is below a desired level. The level desired is when the water bath completely covers the evaporator coil **77** and the drinking water chilled coil **94**.

Referring to FIGS. **2**A and **2**B, the water flow path for adding water to the chilled water reservoir **74** is described. A chiller water reservoir filling solenoid valve **196** is downstream of the flow meter **88** and in fluid communication with the flow meter **88**. The chiller water reservoir filling solenoid valve **196** is also in fluid communication with the inside of the chilled water reservoir through water filling line **198** which advantageously passes through the top of the insulation and top cover or lid or wall of the chilled water reservoir **74**. The electrical signal from the water level sensor **188** (FIG. **4**A) indicating water is needed, results in the chilled water reservoir filling solenoid valve **196** being opened so water flows through that valve and through the filling line **198** to add water to the inside of the chilled water reservoir until the water-bath level **194** reaches a determined threshold. When the water level sensor **188** indicates the water, level is at a predetermined level, the float **190** rises enough to cause the sensor **188** to send an electrical signal to the controller **64** that results in the chilled water reservoir filling solenoid valve **196** being closed to shut off the flow of water into the reservoir **74** through the filling line **198**.

The drink station **20** is shipped without water in the chilled water reservoir **74**. The chilled water reservoir **74** is preferably sealed so no fluid enters or leaves unintentionally, even when the drink station is inclined the fluid inside the chilled water reservoir **74** does not spill out. The water level sensor **188**, and the water reservoir filling solenoid valve **196** and filling line **198** allow water to be automatically added and thus avoid manually carrying water to pour it into the chilled water reservoir, and avoiding the attendant, when the apparatus is installed, set up, or serviced, splashing and spilling of water on electronic and mechanical components. When electrical power to the drink station **20** is activated, the water level sensor **188** indicates that the chilled water reservoir is low on water, resulting in opening of the chilled bucket valve **196** until the chilled water reservoir **74** is filled until the float **190** rises to a predetermined level and an electrical signal is sent that results in the valve **196** being closed to shut off the water. If water is lost through evaporation and the water level **194** in the reservoir **74** falls then the water level sensor **188** can send a signal to the controller **64** to automatically add more water to maintain the water level **194** within a predetermined range of water levels.

A user may push the auto-fill button **60**, or any predetermined sequence of buttons (FIG. **1**) to cause the above described system to check the water level **194** in the chilled water reservoir using the water level sensor **188** and the received signal from that sensor may be used by a controller **64** to implement a fill cycle to top off the water level and bring it up to the full level. This manual check-and-fill provides a redundant system in the event the user believes the system is not automatically refilling, or in the event the user wants to ensure the chilled water reservoir is topped off, so the maximum volume of water in the cold water reservoir is available for an expected period of high usage of chilled water from the chilled water coil **94**. This manually activated solution and the associated circuitry to manually activate the water level sensor **188** and a potential fill cycle, is alternative to the automatic filling.

The various water lines and electrical connections for components contained inside the reservoir **74** preferably pass through sealed openings in the top of the reservoir **74** and through the insulation on that top. Some electrical wires for such electrical communication are shown in the figures, and various fluid lines are shown in the figures. Such sealed connections are known and not described in detail herein. The sealed chilled water reservoir **74** is believed to offer advantages other than avoiding the risks of adding water to a reservoir surrounded by electrical connections and fluid lines. It makes performance more consistent because the water level **194** in the chilled water reservoir is controlled so the ice bank **178** has a more uniform thickness and volume which maintain the temperature of chilled water in the reservoir at a more constant temperature, and that maintains the temperature of the dispensed beverages at a more uniform temperature. Further, the sealed water reservoir **74** also reduces leakage of water from the reservoir into the surrounding environment, including its electrical and fluid connections, as may occur if the drink station **20** were tilted during repositioning of the drink station, or as may occur if the drink station were on a vehicle, boat or ship that tilts and sways.

The details of forming a sealed water reservoir **74** are not disclosed in detail. Advantageously though, a container may be formed with welded seams, and a top lid with appropriate sealed passages for the fluid lines and electrical wires may be provided. Rubber or silicon or other elastomeric sealing passages are known, and viscous sealant that hardens with time can also be used to seal such passages for fluid lines and electrical lines in the lid or container. A ring seal such as an O-ring seal or a labyrinth seal may encircle the lid or top of the reservoir to provide a fluid tight seal with the sidewalls of the container/reservoir.

Referring to FIG. **3**A, the refrigeration system is shown in more detail. The compressor **70** compresses the refrigerant into a liquid and pushes it through the freezer expansion line or evaporator coils. The freezer expansion line **72** (i.e., evaporator coil) is shown in FIG. **3** as being wrapped in the shape of a cylinder with a generally square cross-section, to create an evaporator coil. The refrigerant turns into a gas as it passes through the freezer expansion line and absorbs heat from the water or ice inside the reservoir. The gaseous refrigerant returns to the compressor, where the cycle begins again with compressing the refrigerant. The heat generated by the compressor **70** is dissipated by the heat exchanger **78** and fans **79** which transfer the heat to the air blown through the exchanger **78** by the fans **79**. A capillary tube **200** in the refrigerant flow circuit restricts the flow of the refrigerant a predetermined amount to vary the temperature. A drier **202** also in the refrigerant flow circuit removes moisture from the refrigerant. After the condenser, the refrigerant enters the drier **202** and the capillary tube **200** (the low-pressure side) then it enters again the water reservoir where the heat exchanging happens with the water-bath inside the water reservoir and the circulation cycle repeats. The depicted coil also shows the ice temperature sensor **180** that is advantageously located at a predetermined distance apart from the evaporator coil **77** (here the square-shaped coil) to control the thickness of the ice bank **178** (FIG. **4**A).

Referring to FIGS. **1**D, **2**A and **2**F, the drink station **20** has an electrical connection **204**, preferably on the back of the drink station, to provide electrical power to the various electrical parts and sensors in the drink station. A standard electrical socket is believed suitable, configured to connect to a building electrical line through an appropriate electrical cord. The electrical connection **204** provides electrical power to the various valves, pumps, controllers (e.g., controller **64**), lights and other electrically powered devices. Advantageously, the electrical connection **204** is in electrical communication with a transformer **206** (FIG. **11**A) that reduces the electrical line voltage (120 V AC or 240V AC) to a smaller direct current voltage. A DC voltage of 24 VDC is believed suitable, and most or all of the various electrically powered components and sensors used herein may advantageously be configurated to operate on that DC voltage. The electrical heating element **154** may operate on the higher line voltage, or on a higher DC voltage.

Alkaline Cartridge

Referring to FIG. **5**, the alkaline cartridge **102** is described in more detail. The alkaline cartridge resembles a water filter cartridge except that the contents of the filter material are changed. Such water filter cartridges are described in various patents, including U.S. Pat. Nos. 7,763,170 and 8,182,699. The complete contents of all U.S. patents, published and unpublished patent applications identified herein, are incorporated herein by reference.

The alkaline cartridge **102** has cartridge housing **210** that is typically cylindrical and extends along a longitudinal axis. The alkaline cartridge **102** has a cap **212** with a fluid inlet **214** and a fluid outlet **216**. In the depicted embodiment the cap **212** is cylindrical and extends from the top end of the cartridge with a cammed mounting lugs **218** extending radially outward from at least two opposing sides of the cap. Each cammed lug **218** has a contoured top surface configured to mate with a corresponding surface in a manifold in the drink station that is described later. The fluid inlet and outlet **214**, **216** are coaxial and extend along the longitudinal axis of a nozzle **220** extending from the center of the cap along the longitudinal axis of the cartridge. The nozzle **220** typically has one or more ring seals such as O-ring seals, encircling the nozzle to form a fluid seal with a mating surface in the manifold as described later. In the depicted embodiment the inlet **214** is an annular flow path encircling the cylindrical and centrally located outlet flow path **216**, but the order and flow direction can be reversed. Also, other nozzle configurations can be used, including physically separated nozzles on different parts of the cap for each of the inlet and outlet.

The water inlet **214** is preferably in fluid communication with an inlet dispersing disk **222** that is shown as having a circular periphery with a plurality of axially aligned passages extending through the disk. An annular rim extends upward around the periphery of the disk. The disk and rim are sized to fit in a fluid tight manner with the inside of the (preferably cylindrical) housing **210**. Inflowing water from inlet **214** hits the disk **222** and spreads outward and passes axially through the disk. The annular rim confines outwardly flowing water to the top surface of the disk and redirects water inward and through the axially aligned passages.

A bed of alkaline material **224** is located below the disk **222** and the disk advantageously restrains the top of the bed of material to retain it in position within the cartridge housing **210**. The bed of alkaline material **224** advantageously comprises ceramic mineral balls made of alkaline materials, sometimes referred to as tourmaline balls, although the balls are advantageously manmade with porous ceramics. Various alkaline minerals may be intermixed with ceramic material or other binders and sintered to form particles, preferably spherical balls. Binders such as silica sol, polyvinyl alcohol and kaolin are believed suitable. A ceramic composition comprising 10-30 wt % of Al2O3; 10-30 wt % of SiO2; 0.1-1 wt % of P2O5; 0.1-5 wt % of K2O; 0.1-5 wt % of TiO2; 0.1-0.5 wt % of Fe2O3; 1-10 wt % of ZrO2; 0.1-1 wt % of AgO; 0.1-1 wt % of ZnO; 1-5 wt % of Na2O; 0.5-10 wt % of CaSO3; 5-20 wt % of a calcium oxide antibacterial agent; and 0.1-2 wt % of a binding agent is believed suitable. The binding agent may include silica sol, poly (vinyl alcohol) and kaolin.

Various alkaline minerals and/or electrolytes may be made into a powdered form, rolled into spheres or balls, preferably with suitable binders, and sintered or fired to fasten the materials together. Water dissolves the alkaline materials as it passes through the alkaline bed **224**. Alkaline materials include calcium, magnesium, manganese, potassium, iron, phosphorous, sodium and zinc. Others may be used. The alkaline bed **224** is designed so that the water passing through the bed and out the alkaline cartridge **102** has a PH of 7.2 to 10.0.

After passing through the alkaline bed **224**, the alkaline water passes through a filter **226**, preferably an ultra-filtration layer, and/or a nano-filtration layer or membrane. The filter **226** is layered between the bed of alkaline material **224** and a bed of activated carbon **228**, preferably granular activated carbon (GAC). A second, bottom disk **230** is located below and holds the bottom of the bed of activated charcoal **228**. The bottom disk **230** advantageously seals against the inner surface of the housing **210** and has a plurality of passages extending through the disk and axially aligned with the longitudinal axis of the cartridge **102**. The bottom disk **230** advantageously has a downwardly extending annular rim encircling the periphery of the bottom disk **230**, to form a chamber between the portion of the disk with passages and a closed bottom **232** of the cartridge **102**.

A central tube **234** extends along the longitudinal axis of the alkaline cartridge **102** and places the chamber at the bottom of the cartridge in fluid communication with the outlet **216**. During use, water flows into the inlet **214** and downward. The water is spread by the top disk **222** over the top of the bed of alkaline materials **224**. The filter layer **210** removes mineral particulates from the water and as the water passes downward through the activated carbon layer **228** to further polish the water and improve its taste. Additionally, the GAC slows the flow of alkaline minerals and avoids or reduces sudden changes in alkalinity due to a sudden release of minerals in the water. After passing through the charcoal bed **228** the filtered collects in the bottom chamber between the bottom disk **230** and the bottom of the cartridge **102** where it flows up the central tube **234** and out the outlet **216**.

The alkaline cartridge **102** is removably connected to a manifold **240** mounted in the drink station. As seen in FIG. **1**, the drink station **20** has an access door **250** in one side of the drink station, and that allows access to the alkaline cartridge **102** to remove it from the manifold **240**, and replace it with a fresh alkaline cartridge when the alkaline bed **224** is depleted or when the cartridge otherwise needs replacing.

Referring to FIGS. **2**D and **5**, the manifold **240** has an inlet port **244** in fluid communication with the ambient water valve **102** to receive a flow of water when the valve opens. The manifold **240** also has an outlet port **246** in fluid communication with the spigot **44** through the alkaline line **104**. The bottom of the manifold has a receiving recess (not shown) that is configured to receive and mate with the nozzle **220** and its encircling O-rings to form a fluid tight connection between the manifold **240** and the alkaline cartridge **102**. The bottom of the manifold has a receiving holding mechanism (not shown) with flanges located to mate with the cammed mounting lugs **218** to hold the alkaline cartridge from being pushed axially out of the manifold **240** by water pressure.

During use, the access door **242** (FIG. **1**) is opened, the used alkaline canister **102** is rotated to disengage the lugs **218** from the manifold **240**, and the canister is removed. A new canister **102** is inserted into the manifold and rotated to engage the lugs **218** with mating surfaces in the manifold and seal the cartridge nozzle **220** to the mating surface in the manifold. Plain water flows into the manifold inlet port **244** and out the manifold cartridge outlet **250** and then into the cartridge inlet **216**. After passing through the various beds **224**, **228** and filters **210** in the alkaline cartridge, the (now) alkaline water passes up the central tube **234** and through the cartridge outlet **216** and into the manifold cartridge inlet **248** and then out manifold outlet **246** an into the alkaline water line **104**.

Hot Water Tank

Referring to FIGS. **2**A, **2**G, and **6**A-**6**B, the hot tank **152** is described. The hot tank **152** has a tank housing **260** having insulation **261** on at least portions of the outer surface of the housing. The tank housing **260** encloses a hot water reservoir **262** in a lower or bottom portion of the housing and a vapor chamber **264** in the upper or top portion of the tank housing. The tank housing **260** is shown as having a rectangular configuration with insulation **261** on the top and bottom surfaces of the tank housing, but other configurations can be used. A heater **154** extends from a bottom of the tank housing **260** upward and is located near a first end of the housing **260**. The heater **154** advantageously includes an electrical resistance heating element enclosed in a stainless-steel enclosure to reduce scaling on the outside of the heater when it is immersed in the water being heated.

The heater **154** extends a predetermined distance upward into the hot water reservoir. A temperature sensor **156**, preferably a thermistor and more preferably an NTC sensor, extends from the end wall into the hot water reservoir. The temperature sensor is preferably an NTC sensor in a stainless-steel housing and is advantageously located very close to (within 1 mm) the flat top of the heater **150**, and preferably located so it physically contacts the top of the heater **150**. If the temperature sensor **156** contacts or nearly contacts the heater **156**, a spike in the temperature at the sensor **156** can indicate a low water level in the hot water reservoir **262**. The temperature sensor **156** is in electrical communication with a controller **64** that uses the sensor's signal to either apply or shut off electrical power to the heating element **268** to maintain the temperature of the water in the hot water reservoir **262** within a predetermined rage of temperatures. A controller **64** that activates the heating element 26° F. at 170° F. and shuts off the electrical power at 210° F. or 99° C. is believed suitable.

A thermostat **158** is located in the end wall of the tank housing **260** adjacent the heater **150**. In the event the temperature sensor in the thermostat **158** fails and the water in hot water reservoir **262** gets above a predetermined threshold, the thermistor **156** sends a signal to the controller **64** that results in cutting off electrical power to the heating element. A layer of water separates the thermostat **158** from the adjacent heater **150** so the thermostat senses the temperature of the water, preferably the temperature at the bottom end of the heater and the hot tank. The thermostat **158** regulates the temperature of the heater **154**. The thermostat **158** may be attached at any other locations within the hot water reservoir as long as it measures the water temperature and is immersed most of the time. The thermostat **158** normally opens an electric circuit interrupting power to heater **154** when the temperature of hot tank exceeds 100° C. The maximum temperature can be varied, and it is not uncommon for other water heaters in drink stations to have the maximum temperature at 120° C.

The vapor chamber **264** is separated from the hot water reservoir **262** by a dividing wall **274** that separates the hot water reservoir **262** from the vapor chamber **264**. A first tube, control tube **276**, has a first end that extends through the top side of the hot tank housing **260** so the first end is located outside the tank housing **260** where it may be connected to the hot water line **160**. The control tube **276** has an opposing, second end referred to a slotted end **278**, which is in fluid communication with both the hot water reservoir **262** and the vapor chamber **264**. The slotted end **278** has a plurality of slots **280** extending along a longitudinal axis of the control tube **276** and extending through the wall of the hollow tube. Four, equally spaced slots **280** are used in the depicted embodiment. The control tube **276** is preferably of stainless steel to reduce corrosion and scaling that may alter the slot dimensions over time.

A vent opening **282** also extends through the wall of the control tube **276** near the end of the slots **280**. The vent opening **282** is small enough that water does not drip out of it when the control tube is filled with hot water, and it provides an air path to ensure hot water does not get air-locked in the control tube **276** and hot water line **160** when the spigot **44** is shut off or closed, as the pressure pulse in the hot water line from shutting off or closing the spigot **44** to stop dispensing hot water will vent through the vent opening **282** and assure immediate venting and backflow of hot water through the control tube into the hot water reservoir **262** in a continuous flow of hot water, and reduces or avoids dripping of water out of the control tube into the hot water reservoir. This vent opening **282** is optional. The slots **280** and vent opening **282** are located inside the vapor chamber **264**. The slotted end **278** is in fluid communication with the hot water reservoir **280** through a discharge opening **284** in the dividing wall **274** which discharge opening is advantageously, but optionally, in an alignment structure.

In the depicted embodiment of FIGS. **6**A-**6**B, the dividing wall has an alignment structure to align the control tube **278** with the discharge opening **284**. The alignment structure is shown as seating recess **286** in the dividing wall **274** with the seating recess shaped to receive the distal end of slotted end **278** and hold the slotted end **278** in a fixed position aligning the center of the control tube **276** with the discharge opening

284. In the depicted embodiment the control tube **276** is a cylindrical tube and the seating recess **286** is a shallow, circular recess in the dividing wall **274**.

A second tube, vent tube **288** extends through the top of the hot tank housing **260** and insulation **261** to be placed in fluid communication with the vent tube **262** and spigot **44**. A water inlet **290** is located in the bottom of the hot water reservoir **262** to place the hot water reservoir **262** in fluid communication with the hot water valve **150** to supply water to the hot water reservoir. The water inlet **290** is shown as a tubular fitting extending downward and sideways to connect to the fluid line from the hot water valve **150**. Optionally, the water inlet **288** may have a deflector or directional device **292** inside the hot water reservoir to direct incoming water parallel with the bottom of the hot water reservoir **262**, so the hot water reservoir fills from the bottom up, pushing the hot water toward the discharge opening restrictor **284**. The deflector brings the incoming water closer to the heater and favor the mixing of the incoming water at room temperature with the rest of the water inside the hot water reservoir **262**. A hot water drain fitting **294** (FIG. **6**A) is advantageously located in the bottom of the hot water reservoir **262** and is preferably at a low point of the hot water reservoir or in a recessed portion so water drains out the reservoir when it is desired to empty the reservoir. The drain fitting **294** is shown as a tubular fitting passing through the bottom wall of the hot water housing **260** and insulation **261** and is located in a drain recess. The drain discharge fluid line for the hot water tank is not shown in the flow diagram of FIG. **2**G but is advantageously in fluid communication with the hot water drain outlet **298** (FIG. **1**D) on the back of the drink station **20**. A further fluid may be connected to the drain outlet **298** to connect the outlet to a building drain line.

Mounting brackets **296** are connected to the housing **260** to connect the hot water tank **152** to supporting structure within the drink station **20**. The depicted mounting brackets **296** are shown as two L-brackets fastened to the bottom of the hot water tank **152**, with the water inlet **290** passing through an opening in one of the brackets

In use, steam from the heated water in the hot water reservoir **262** rises and passes through the discharge opening **284** and into the vapor chamber **264**. If steam condenses into water in the vapor chamber **264**, the condensed hot water passes through the slots **280** in the slotted end **278** of the control tube **276** and through the discharge opening **284** and into the hot water reservoir **262**.

In use, pressing the hot water button **58** opens the hot water valve **150**, which opens to pass water through the water inlet **240** in the bottom of the water tank **152**, where the deflector **292** directs the incoming water parallel to the bottom of the hot water reservoir **262** and forces the hot water at the top of the reservoir up and into through the discharge opening restrictor **284** and through the control tube **276** and into the hot water line **160** to the spigot **44** for discharge. As water is forced through the discharge opening restrictor **284** and into the hot water line **160** it creates a suction effect that draws steam from the vapor chamber through the slots **280** and into the stream of water passing through the hot water line and through the spigot **44**. The steam contains more energy than hot water and provides a more efficient heating system to provide hot water at the spigot **44** and provides extra heat energy to compensate for the heat loss as the hot water passes through the hot water line **160** which is preferably hot actively heated, although it is insulated. All of the chilled water lines in the drinking station may be insulated.

When the spigot **44** closes, the cessation of fluid flow causes a reflux pressure which can push hot water into the vapor line **162** and back toward the hot water tank **152**. The vapor line **162** acts as a ventilation line so that a vacuum lock in the hot water line **160** does not prevent the hot water from flowing back into the hot water tank **152**, but instead air pressure urges the hot water to flow back along fluid passage **160** (and if water enters it, along vapor line **162**) from the spigot **44** through the hot water line **160** and into the hot water tank **152**. The vent opening **282** also allows fast reflux or return of hot water to the hot water reservoir **162** as the pressure pulse from closing the hot water dispensing spigot **44** may ensure the water in the control tube **276** is not air locked and instead flows out of the tube and into the hot water reservoir. Hot water returning through the hot water line **160** passes into the hot water reservoir **262** while hot water from the vapor line **162** passes into the vapor chamber. The vent opening **282** also reduces small volumes of water from being trapped by an air lock in the control tube **276** or slotted end **278**. Water in the vapor chamber from any source passes though the slots **280** in the slotted end **278** of the control tube **276** and passes through the discharge opening **284** and into the hot water reservoir **262**. The hot water line **160** from the hot water tank **152** to the spigot **44** is advantageously inclined at least slightly upward, so that gravity urges the hot water to flow backwards from the spigot to the hot water tank.

The volume of the hot water tank **152** is selected based mostly on the volume of hot water demand, with a larger tank **152** used when a large volume of hot water is expected to be dispensed at spigot **44**. The relative volumes of the vapor chamber **264** and hot water reservoir **262** are also important because the vapor chamber **264** reduces the usable volume of hot water in the hot water reservoir **262**, and if the volume in the vapor chamber **264** is too small then reflux water from shutting off or closing the spigot **44** can enter the vapor chamber **264**. Similarly, the inflow of water into the hot water reservoir **262** is important so that hot water flows through the control tube **276** and spigot **44** rather than flow into the vapor chamber **264**. The relative flow through the discharge opening restrictor **284** and input fitting **294** are regulated to achieve optimum operation, with the discharge opening **284** acting as a flow restrictor to ensure pressure to force hot water through the discharge tube and create a vacuum in the vapor chamber **264** that sucks out the hot vapors rather than flood the vapor chamber with hot water flowing through the slots **280**. In a sense, the flow through the control tube **276** is regulated so the hot water passes through the restrictor **284** at a flow rate sufficient to create suction at the slots **276** rather than flowing water through the slots and into the vapor chamber.

Conceptually, the volume and pressure of water entering the hot water tank **152** and the volume and pressure of water exiting through the control tube **276** are balanced to create a suction at the slotted end **284** located inside the vapor chamber **264** that entrains steam from the vapor chamber into the hot water flowing upward to the spigot **44**, with sufficient pressure to flow the hot water upward to the spigot. In one preferred embodiment, the water inlet **294** has a diameter of 4.4 mm to provide a flow rate of 1 liter per minute through the discharge opening **284** so that the hot water from the chamber will pass through the smaller sized flow restrictor formed by discharge opening **284** which has a diameter of 3 mm at a flow rate sufficient to suck hot water vapor through the slots **280** and into the water stream entering the hot water line **160** and to the spigot **44** which is at an elevation higher than the hot water tank **152** and the hot water outlet **276**. The slots **280** are advantageously sized to create a venturi effect when the minimum desired flow rate is achieved. Four slots 1 mm wide and 4-5 mm long are believed suitable in the preferred embodiment. A vent opening **282** about 2-3 mm diameter is believed suitable for the above described slotted end **278**. Advantageously, the flow rate of 1 liter per minute is a minimum flow rate at a line pressure of 40 psi and is selected as a design criteria because most municipal water lines have a line pressure that is 40 psi or greater.

Using a hot water tank **152** located below the dispensing spigot **44** is believed to offer several advantages in connection with the design of the beverage dispensing system. The discharge opening **284** is sized smaller than the fluid inlet **290** which increases the discharge pressure with which hot water is forced from the hot water tank **152** and that increased pressure is used to push the hot water to the spigot **44** which is higher than the hot water tank. That increased discharge pressure is used to create the venturi effect which sucks steam from the vapor chamber **264** and entrains it in the stream of water directed to the spigot **44**. The inflow of water through the inlet **290** at the line pressure (or other regulated pressure above 40 psi) is directed by deflector **292** to force the hottest water at the top of the hot water reservoir **262** out the discharge opening. The location of the hot water tank **152** below the spigot **44** allows water to drain with gravity and return to the tank (once the vent line **162** releases the vacuum that might hold the water in the line) and thus allows the spigot to be cooler than if it remained in thermal contact with the hot water in the hot water line **160** even when no water was being dispensed.

Carbonators

Referring to FIGS. **2**E, **3**B-**3**D, and **7**A-**7**C, the electronic carbonation system is described. This system is described in U.S. patent application Ser. No. 16/329,043, filed Feb. 27, 2019, titled Method and Apparatus for Instantaneous On-Line Carbonation of Water Through Electrostatic Charging, the complete contents of which are incorporated herein by reference. Briefly described, an apparatus is provided for carbonating a mixed input flow of pressurized and refrigerated carbon dioxide and water. A first cartridge is disposed within a carbonation chamber that includes porous micromesh net in fluid communication with an input flow and a central cavity in fluid communication with the carbonation chamber output port. The micromesh net is configured to break up chains of water molecules passing through the net, to enhance bonding between the water and carbon dioxide molecules within the cartridge. The micromesh net also responds to the flow of water and carbon dioxide molecules impacting and passing through the net by generating a passive polarizing field that has a polarizing influence on the water molecules to further enhance carbonization. Beads may be provided within the cartridge for capturing and stabilizing carbon dioxide molecules to yet further enhance bonding between the water and the carbon dioxide molecules.

More specifically, in reference to FIGS. **7**A-**7**C, the construction is described first, then the operation. The first carbonation chamber **120** defines an interior having a first (preferably cylindrical) micromesh net **334** and optionally a plurality of cylindrical nets or a plurality of first glass beads **325**. The second carbonation chamber **121** defines a similarly shaped interior having a second plurality of glass beads **333** within a second (preferably cylindrical) micromesh net **336** like that of net **334**.

The carbonated water lines from the cold water and carbon dioxide mixed in the venturi in the splitter **119** (FIG. **2**E) or the intermixing venturis in fluid lines **138**, **140**, **142** (FIG. **2**F) are in fluid communication with the input port **322** of the first carbonation chamber **120**. The flow from that first carbonation chamber **120** passes out of first chamber output port **324** and into the second carbonator inlet port **326**. The flow through the second carbonation chamber **121** is from the second chamber input port **326** and out of the second chamber output port **328** which in turn is in fluid communication with the chilled carbonated water line **122**.

The first carbonation chamber **120** defines an interior preferably having a 100 μm micromesh **334** and a plurality of 5 mm glass beads disposed within the carbonation chamber **120**. The micromesh **334** can vary in size. The second carbonation chamber **121** preferably defines a 400 μm micromesh net, within which are plurality of 1 to 3 mm glass beads. The micromesh nets are preferably cylindrical.

Each carbonation chamber **120**, **121** thus advantageously has a cap **325** and a base **329**, with the chambers **120**, **121** defined by the cap portion **325** and the base portion **329**. The cap and base are shown as having elongated portions with mating threaded portions at the joined ends so the long body of the cap and base form the respective chambers **120**, **121**. But the cap **325** and base could be shorter and on opposing ends of an elongated tube which forms the main portion of the chamber.

The micromesh net **334** extends about the interior chamber and is shown as forming a cylindrical tube with the glass beads **325** disposed inside the micromesh net **334**. Micromesh net **334** advantageously has a top and bottom support ring (FIG. **7**A). Other devices, including an internal port may be provided to facilitate flow rate between the chambers to facilitate fluid flow between the interior of the micromesh net **334** and the carbonation chamber input port, and to facilitate fluid flow through and about the beads inside the micromesh net. The micromesh net and beads may be provided as a single unit or cartridge, with the grate **334** holding the beads **325** inside the cartridge **327** and net (FIG. **7**A).

Fluid flow into and out of the carbonation chambers may be varied. In use, carbonated water output from the second carbonation chamber **121** communicate to the carbonated fluid line **122** or communicated to a flow compensator which in turn is in fluid communication with the carbonated fluid line **122** and the outlet spigot.

As the water molecules pass through the micromesh net **334**, **336** the charge on the net is believed to influence water molecules orientation because it is known in the art that water molecules are polarized. Such passive polarization, created as a consequence of the interaction of the molecules and the net, thereby enhances the dipole bonding between the water and carbon dioxide molecules.

Alternatively, the micromesh net may be implemented as a pair of concentric nets **334** (FIG. **7**C) connected to a voltage source, to provide active polarization of the nets to enhance orientation of the water molecules passing through the net. The particular orientation of current flow through the nets may be implemented in accordance with the desired polarization of the water molecules as they pass through the nets.

As indicated above, the first carbonator **120** and its carbonation chamber **120**, may include the micromesh net **334**, through which the input water and gas mix passes, is preferably formed of one or more independent rings of micromesh metal, such as stainless steel. The passage of the carbonated water through the micromesh net **334**, breaks the long molecule compounds of water while creating a weak electrostatic field due to the high-speed passage of more polarized molecules which, within a short period of time (less than one second) the more polarized molecules of the fluid mix (water and carbon dioxide) so the short (broken) chains of water molecules have a higher likelihood of forming dipole to dipole electrostatic connections with the carbon dioxide molecules. In the present embodiment, static electric fields are self-induced by the passage of polarized molecules: creating electrical induction. Other embodiments of the same apparatus may utilize a process in which electric fields are artificially generated externally, through a common DC power supply, or multiple DC power supplies, resulting in highly polarized water and gas molecules that are immediately oriented, in accordance with the electrical filed generated on the net. Whichever is the solution adopted (induced electrical field or artificially generated), the result is high polarization and orientation of the molecules of liquid and gas. In case of passively induced electrical fields, not only does the induced static electric field contribute to the polarization of molecules transiting within, but the polarization itself modifies the electric field that is generated.

Although the electrostatic field herein generated by the passage of polarized molecule is expected to be relatively weak, the resulting increase in the polarization of water molecules increases the likelihood of the formation of bonds between the water molecules and the carbon dioxide molecules, whose bonds, as known in the art, are particularly weak. This is because as the degree of polarization of each water molecule is increased the total number of water molecules with a high degree of polarization is increased. By breaking the long chains of molecules and gradually orienting the same, in response to the electrostatic field, there is an increase in the (temporary) formation of carbonic acid inside the water, and the resulting water has been found to be more highly carbonated. In addition, the water molecules have been found to retain a bond with the carbon dioxide molecules that mitigates dispersion of the carbon dioxide molecules, (i.e., bubbling, when the carbonated water is exposed to air during dispensing). As bonds are increased, the carbonization in water is higher and more durable over time, as the carbonated water sits in an open glass or bottle.

In the illustrated embodiments, the micro mesh nets are formed of thin stainless-steel strands of approximately 2 to 100μ in diameter, having an open mesh area of approximately 5 to 800μ. A micro mesh net **334**, **336** may be formed of other materials, and the size of the strands/open mesh areas and may be varied as suited for specific pressure levels, flow rates, desired levels of carbonation and other factors.

Beverage Container Alignment Light

Referring to FIGS. **8A**-**8B**, the drink station **20** is shown having only four drink dispensing buttons instead of five as in FIG. **1A** and having a drink alignment mechanism **350**. The drink alignment mechanism may be used with the embodiment of FIG. **1**, as may the fewer number of buttons. The four drink dispensing buttons are dispensing button **52** for carbonated or sparkling water, button **56** for chilled water, button **58** for hot water, and button **54** for alkaline water. The auto-fill button **60** is omitted. Four buttons allow the use of larger buttons and larger printed indicia on the buttons to identify which button activates the dispensing of which beverage. Advantageously, the drink buttons are on the top portion of the drink station, above the filling area **40** and drain pan **46** and drain grate **48**, but the location can be varied. A plurality of indicator lights **62** are also advantageously on the top panel of the front of the drink station, with the indicator lights **62** preferably including a red light to indicate if hot water is available, and with another light that indicates the water filter or alkaline cartridge needs replacing. Various ways of achieving the electrical connection and activation of these indicator lights are known and not described herein.

Advantageously, a single spigot **44** is used to dispense all of the beverages, as in the drink station of FIG. **1**. The drain pan **46** and its drain grate **48** preferably extend across a substantial width (i.e., side-to-side) of the front of the drink station **20** so a user may set several beverage containers or drink cups **354** on the drain grate for faster and easier filling of the containers and cups. To help the user visually align the cup with the spigot a light bar **352** is provided that extends vertically and is aligned with the dispensing nozzle of the spigot **44**. The visual alignment avoids difficulties associated with using a circular, cup-sized recess below the dispensing spigot to align the cups with the spigot because the recess creates an offset that allows cups to tilt and fall over when empty or when being filled.

The light bar **352** advantageously takes the form of an elongated, lighted member that is electrically controlled to create a visual light that moves from the top of the filling area **40** downward toward the bottom of the drink station and drain pan **46** in a repeating pattern, and with the visual length of the light bar aligned in a vertical plane through the spigot and parallel to the opposing, rectangular sides of the drink station **20** as shown in FIG. **8A**. The light bar **352** is connected to the sidewall **42** that separates the filling area **40** from the inside of the drink station. The light bar **352** advantageously includes a plurality of LED's **356** arranged in a vertical line on the sidewall **42** and extending downward from a location on the sidewall behind the spigot **44** and vertically aligned with the spigot **44** on that sidewall. If the beverage container is aligned laterally along the width of the drain grate **48**, the spigot **44** will dispense its stream of liquid into the center of the beverage container.

Advantageously, the light bar **352** includes a plurality of LED's **356** close enough together that each individual LED may be separately and sequentially activated by a timer and control circuit to create a repeating pattern of lights extending from the top of the light bar to the bottom of the light bar. Advantageously, the LED's are located behind a strip of clear or translucent plastic that forms a shield, so the LED's **356** are shielded from the dispensed beverages being splashed on the LED's. Advantageously, an elongated slot in the sidewall **42** may be formed with the plastic shield filling the slot for easy cleaning. The illuminated light bar **352** allows a user to visualize the stream of liquid dispensed from the spigot **44** and assists in aligning a beverage cup with the dispensed liquid.

As indicated by the dashed lines in FIG. **8B**, if the drink station **20** has more than one spigot **44**, more than one light bar **352** may be used, with one light bar **352** associated with a different one of the spigots and aligned with that spigot as described above. A continuously lit light bar **352** is believed usable, but less desirable. The timing and electrical control circuits to achieve the repeating cycle of moving lights is known, as reflected by various holiday lighting decorations, and are not described in detail herein.

Each of the LED's **356** or other light source for each of the light bars **352** is in electrical communication with the controller **64** which contains electrical circuitry to activate the lights in a stationary or repeating pattern when electrical power is provided to the controller **64**, or when a drink selection button **52**, **54**, **56**, **58** or **60** is activated. The controller may contain a timer circuit that shuts off the lights after a predetermined time of illumination without intervening activation of one of the drink selection button. If a light bar **352** is provided for each spigot the light bar only for that spigot may be activated to provide the described lamination.

System Operation

There is thus advantageously provided a dispensing apparatus (FIG. **2**A-**2**G) such as drink stations **20** for chilled and sparkling drinks that includes a main water inlet port **86** and one or more water flow lines in fluid communication with the devices described below, including a water delivery pump **92** which is in fluid communication with at least one stainless steel drinking water chiller coil **94** that is at least partially inserted into a heat exchanger that preferably takes the form of a chilled water reservoir **74**, to chill the incoming water from the water delivery pump. Other heat exchanging devices can be used, but the chilled water bath achieved with the chilled and insulated reservoir **74** is preferred. A water line splitter **132**, preferably located inside or downstream of the drinking water chiller coil **94** splits the chilled water line into at least one chilled water line **98** in fluid communication with the spigot **44**, and at least one sparkling water line **122** that is ultimately in fluid communication with the spigot **44**. The beverage station also has a normally closed chilled water valve **96** positioned downstream of the drinking water chiller coil **94** and downstream of the water line splitter **132**.

A normally closed sparkling carbonation, such as water valve **116** is positioned downstream of the drinking water chiller coil **94** and downstream of the water line splitter **132**. At least one normally closed carbon dioxide valve **112**, preferably a valve, is positioned on the gas line from the internal carbon dioxide gas canister **108** to a static venturi-restriction device **144** (FIG. **2**F) or the venturi in the splitter **119**. The at least one static venturi-restriction device (**144**, **119** splitter with venturi) allows carbon dioxide gas to enter into the chilled water, preferably at a location downstream of the drinking water chiller coil **94**. Preferably, one or more static in-line carbonation chambers **120**, **121** produce instantaneous and additional carbonation of the water, device **120**, **121** positioned downstream of the venturi devices **144**, **119** (splitter with venturi), and at least partially inserted into the heat exchanger of the chilled water reservoir **74** and preferably adjacent drinking water chiller coil **94**.

An electronic controller **64** is configured to control the water delivery pump **92**, and the three normally-closed valves **96**, **116** and **112** and is in communication with these valves and with the drink selection buttons **52**, **56** associated with those valves and the dispensing of chilled water and carbonated water from the spigot **44**. Advantageously, the controller **64** is in electrical communication with the identified valves and buttons through the electrical communication lines described herein, or such other electrical communication lines as are appropriate to the specific application. These three valves are normally closed so drink dispensing apparatus has a the normally closed chilled water valve **96**, a normally closed sparkling water valve **116** and a normally closed carbon dioxide gas valve **112**.

The beverage dispensing apparatus **20** has at least two selectors, such as buttons **52**, **56** to alternatively dispense either chilled still water or chilled carbonated water. When the chilled still water selector **56** is activated, the water delivery pump **92** is powered on by the controller **64**, and the normally closed, chilled water valve **96** is excited electrically to open and allow chilled still water to be dispensed from spigot **44**. When the chilled sparkling selector **52** is activated, the water delivery pump **92** is powered on, the sparkling water valve **116** and the carbon dioxide gas valve **112** are both excited to open to allow carbonated water to be dispensed from spigot **44**.

While the beverages are described as being dispensed from the same spigot **44**, they could be dispensed from separate spigots or from other dispensing devices. Further, when the electricity used to open the normally closed valves described herein is removed or shut off, the valves close. Thus, they are described as being “excited to open.” The closed valve may be considered to be shut off or turned off, and an open valve may be considered as being turned on as with a water faucet in a sink. Thus, open and closed valves correspond to opening and closing valves or turning valves on and off. But regardless of the detailed operation, the controller **64** or control module **64** contains opens and closes the various valves and turns power to various pumps on and off and applies power to and receives signals from various sensors. The basic control schematics for the electrical controls are described herein, but other control circuits and control logic and modules are believed usable.

In further variations of the above described beverage dispensing apparatus **20**, the normally closed main inlet valve **90** is positioned downstream of the main inlet port **86** and controlled by the controller **64** such that when any selector button **52**, **54**, **56**, **58** or **60** is activated, the main inlet valve **90** is excited and opens. The apparatus **20** preferably includes a flowmeter **88** electrically connected to the controller **64** that allows the controller **64** to measure the quantity of water passing through the flowmeter, and thus to indicate the volume or quantity of water being dispensed through the spigot **44**. Such control, communication and volume measuring is known in the art and not described in detail herein. The apparatus **20** also may have an ambient temperature water line **104** in fluid communication with a normally closed ambient water valve **100**, in communication with the controller **64**, and preferably in electrical communication with the controller **64** and an ambient water selector button mounted adjacent the other buttons. When the ambient water selector button is activated, a signal is sent to the controller **64**, opens the ambient water valve **90** to allow ambient temperature water to be dispensed when the valve **90** is in fluid communication with the spigot **44**, without any intervening devices that change the character of the ambient temperature water.

There is also provided a beverage dispensing apparatus for chilled, sparkling and alkaline water production that includes the beverage dispensing apparatus described above, including the main water inlet port **86** in fluid communication with the water delivery pump **92**, at least one stainless steel drinking water chiller coil **94** that is at least partially inserted into a heat exchanger shown in the drawings as chilled water reservoir **74**. The dispensing apparatus **20** also includes the chilled sparkling water line with at least one carbonation system at least partially inserted into the same heat exchanger, with the carbonation system including the canister **108** of carbon dioxide gas, at least one venturi **140** in the splitter **119** or intersecting fluid lines **114**, **138**, **140**, **142**, and/or the carbonation chambers **120**, **121**. The dispensing apparatus includes the normally closed chilled water valve **96**, the normally closed sparkling water valve **116**, the least one normally closed carbon dioxide gas valve **112** positioned on a gas line from the carbon dioxide gas tank **108**.

This dispensing apparatus further advantageously include an ambient temperature water line **104** in fluid communication with filtered water at the input port **86** or in fluid communication with water filter **130**, both of which (when present) are in fluid communication with the normally-closed ambient temperature water valve **90**. This apparatus further advantageously includes an alkaline chamber **102** that release pre-selected minerals into the water and positioned in fluid communication with the ambient water line **104**, downstream of the normally closed ambient temperature water valve **100**. When the alkaline selector **54** is activated, the electronic controller **64** opens both the ambient water valve **100** and also opens the chilled water valve **96** so that both ambient water from the alkaline chamber **102** (i.e., alkaline water) and chilled water are both dispensed and mixed at the outlet, such as spigot **44**.

In further variations of the alkaline water dispensing apparatus, the controller **64** opens and then closes the chilled water valve **96** for a time interval which is shorter than the time interval that the ambient water valve **100** stays open. That provides more chilled water to the fluid outlet (e.g., spigot **44**) which both cools the water at the outlet and reduces the alkalinity of that water. In still further variations of the alkaline water dispensing apparatus, the alkaline chamber includes a cartridge containing mineral crystal balls inside a bed having granular activated carbon (GAC). Advantageously, the cartridge is configured so that it is releasably fastened to a fluid manifold in the apparatus **20**, and is preferably configured so the cartridge can be easily be changed by rotating it to unlatch the cartridge from the fluid manifold after which the cartridge is moved axially out of the manifold. Other releasable connections are known for connecting water filter cartridges to refrigerators and those releasable connections may be used with the alkaline cartridge.

In still further variations on the above beverage dispensers **20** with the internal carbon dioxide gas canister **108** and the carbonators **120**, **121**, and the alkaline canister **102**, the dispenser may contain a hot tank **152** with a hot water reservoir **262** in fluid communication with the main water valve **90**, preferably a normally closed valve **90**, and hot water valve **150**, which is also preferably a normally closed valve. The valves **90**, **150** and hot water selector **58** are in communication with the controller **64**. When the hot selector **58** is activated, the hot water valve **150** and the main water valve **90** are excited to open and allow inflowing ambient temperature water from the main valve to force hot water from the top of the hot water tank into hot water line **160** which is in fluid communication with an outlet, such as spigot **44**. Advantageously, the hot tank includes a vapor chamber in fluid communication with a hot water reservoir so that steam may collect in the vapor chamber. The hot water flows through a control tube passing through the vapor chamber which tube has a venturi that sucks steam from the vapor chamber into the hot water stream that is ultimately dispensed at the outlet. Advantageously, a return vapor line places the vapor chamber in fluid communication with the outlet, such a spigot **44**, to provide a pressure release that allows the hot water to drain back along the hot water line and into the hot water reservoir in the hot tank. The hot tank **152** advantageously has a heating element **154** inside which is configured to heat the water at temperatures ranging between 205° F. and 170° F., and a temperature sensor NTC **156**, both controlled by the controller **64** to control the heating element and maintain the water temperature within that temperature range. Advantageously the NTC **156** is immediately adjacent to and preferably contacting the heating element to provide a heater shut off if the temperature suddenly changes which is reflective of a water level below the thermistor.

When the water inside the hot water reservoir **262** is at a temperature, as detected by the temperature sensor, at or below the lower setting point, the controller **64** powers on the heating element **154** and keeps it powered on until the temperature of the water reaches the upper setting point as detected by the temperature sensor when the controller **64** stops powering the heating element. If the temperature sensor in the thermistor **158** does not work, the temperature of the wall of the hot tank will increase and the thermostat **156** opens the electric circuit **163** to cut the power to the heating element **154**. The sudden increase of temperature that arise when the water level is low is detected immediately by the thermistor adjacent to the heater and a signal to the controller **64** is sent to cut the power to the heater.

The above described beverage dispensing apparatus **20**, the dispensing nozzle or spigot is in fluid communication with any combination of chilled water through the chilled water line **98**, carbonated water through the carbonated water line **122**, both ambient temperature alkaline water and chilled alkaline water through the alkaline water line **104**, and hot water through the hot water line **160**. These different types of water may be dispensed sequentially, or simultaneously, in any combination by the controller **64** which opens and closes the appropriate valves, including main flow valve **20**, hot water valve **150**, chilled water valve **96**, and carbonation valves **112** and **116**. Additionally, the amount of carbonation can be varied depending on the activation of the carbonators **120**, **121**. The inlet water at inlet port **86** may be filtered or unfiltered, and whether filtered or not, may have one or more internal filters **130**, or external **82**, **84** in fluid communication with the water inlet **86** to further purify the water.

FIG. **2**F shows the filter **130** internal to the beverage dispensing apparatus **20** and upstream of the flow meter **88** and the main inlet valve **90**. Alternatively, the filter or filters **130** internal to the beverage dispensing apparatus may be positioned downstream of the main inlet valve **90** and fluid communication lines are arranged such that the water passing through the main inlet valve **90** goes first through the water filter **130** before passing to each of the hot water valve **150** in fluid communication with the hot tank **152**, the ambient water valve **100** in communication with the alkaline cartridge **102**, the chilled water valve **96** in fluid communication with the drinking water chiller coil **94**, or the carbonation valve **116** in fluid communication with the carbonators **120**, **121** and in downstream fluid communication with the carbon dioxide gas cartridge **108**.

Referring to FIG. **4**A, there is also provided an improved chiller for cooling fluid used for beverages in a beverage dispensing apparatus for chilled and/or sparkling drinks. The apparatus includes a heat exchanger that employs a water-bath/ice-bank refrigeration system to create a cold-water bath and includes technology which includes chiller **74** containing water (the water-bath cooling fluid) and having chiller walls **76** that are thermally insulated from the external ambient temperature to reduce heat dispersion. The chiller or chilled water reservoir **74** contains an evaporator coil **77** that is preferably copper and immersed in the water in the chilled water reservoir **74**. The evaporator coil **77** contains a refrigerant gas which, during its expansion phase, reduces the temperature of the water surrounding the evaporator coil in the chiller **74** and forms an ice bank **178** around the evaporator coil. The chiller includes a drinking water chilled coil **94** preferably made of stainless steel and containing circulating water that is cooled as it passes through the cooling coil, with circulating pressure and flow provided by a water delivery pump **92**. The drinking water chiller coil **94** is at least partially immersed into the water-bath of the chiller and advantageously immersed for the full length of the horizontally extending or laterally extending coils of the drinking water chiller coil **94**.

Referring to FIG. 4A, an inline instantaneous carbonation system configured to mix the water refrigerated inside the drinking water chiller coil **94**, with carbon dioxide gas, is at least partially, immersed into the water bath of the chilled water reservoir. This includes the fluid lines between the carbon dioxide gas valve **112** and the carbonators **120**, **121**. The chiller has an optional discharge line to either drain the water bath from inside the chilled water reservoir by gravity through drain **126** (FIGS. **2**A-**2**B) in the bottom of the cold-water reservoir. At least one temperature sensor **182** is arranged inside the chilled water reservoir **74** and positioned in contact with the drinking water chiller coil so that when the temperature of the drinking water reaches a predetermined value at least one agitator pump **170** is activated with the agitator pump configured to circulate the chilled water in the chilled water reservoir **74** or chiller so the water circulated by the agitator pump circulates around and is preferably in thermally conductive contact with the ice **178**.

The agitator pump **170** advantageously includes a submersible pump inside the chilled water reservoir **74** and advantageously located at one of the bottom or top of the drinking water chiller coil **94**, and advantageously aligned with a central, longitudinal axis of that drinking water chiller coil **94**. Preferably, there are two agitators **170** each with a water intake located on that central, longitudinal axis and each with a plurality of radial water outlet ports which outlet ports are preferably in a plane orthogonal to that longitudinal axis. More preferably, the water flow of each of the two agitators **170** creates a spherical circulation flow pattern extending from the agitator pump outlet ports to about halfway to the other agitator.

Advantageously, the controller **64** is in communication, and preferably in electrical communication with a water level sensor **188** that senses the water level **194** of the chilled water reservoir and when the water level reaches a predetermined low level, the sensor sends an electrical signal (or other type of signal) to the controller **64** which sends a signal that opens the normally closed chilled water valve **196** to fill the water level **194** up to a maximum water level determined by the sensor.

Referring to FIGS. **3**A and **4**, the freezer expansion line **72** which is the evaporative line or coil of the refrigerating system of FIG. **3**A shown schematically in FIG. **4**A, is advantageously formed into a single tubular coil that conforms to the shape of the water reservoir thereby forming the evaporator coil **77**. In the FIGS. **3**A and **4** evaporator coils are shown as a generally square shape, so the coil **77** has rounded corners with straight sides forming the coil.

Referring to FIGS. **9**A-**10**B, the refrigeration system comprises a freezer system (as does the system of FIGS. **3**A and **4**) and is referred to as a freezer system. The freezer system's evaporative coil may advantageously have a coiled configuration arranged in a figure eight coil **401**. Thus, a single, continuous evaporator coil **401** having a uniform diameter along its length, may be wound to produce a figure eight freezing coil effectively forming two separate tubular freezer coils **402**, **404**, each tubular coil surrounding a separate chilled water reservoir so that two chilled water reservoirs **412**, **414** are formed (one within each portion of evaporator coil **402**, **404**), resulting in two chilled water reservoirs within a single housing formed the freezer system's single, evaporative line that forms the figure eight evaporator coil **401**. This figure eight coil arrangement **401** results in an enlarged center ice bank that helps form the two water reservoirs within the single housing. This figure eight configuration is believed to provide an increased volume of chilled water for periods of high demand, and the central ice bank is believed to provide a more uniform and colder temperature of the chilled water than designs using the single tube evaporative freezer line **72** (or evaporator coil **77**) as in FIGS. **3**A and **4**. While the single drinking water chiller coil **94** may contain 0.3 liter, the figure eight coil **422**, **424** may contain 0.6 to 1 liter of drinking water. The single chilled water coil **94** in its chilled water reservoir **74** may advantageously produce over 6 gallons per hour of water at 40° F. or colder. The figure eight chilled water coil **422**, **424** in its chilled water reservoir is believed to produce more than twice that volume and up to 15 gallons per hour of water at 40° F. or colder.

Figure Eight Evaporative Freezer Coil

A single tube **401** of the refrigeration system's evaporative line that freezes water on the outside of the evaporative line advantageously forms the figure eight cooling coil **401**, with that single tube **401** bent to form a series of figure eights extending in a serpentine manner with each successive figure eight stacked above the prior ones to form a figure-eight coil extending upward along the vertical axis. The material of the freezer coil is made in copper or other suitable metals. The refrigeration system forming a figure eight evaporator coil **401**, is thus bent to form first and second, interconnected, tubular coils **402**, **404**. First freezer coil **402** forms one portion of the figure eight coils and the second freezer coil **404** forms the other portion of the stacked figure eight coil **401**.

The tubular arrangement of the coils **402**, **404** is advantageously formed with two opposing, straight and parallel sides. Each figure eight is formed by plurality of coil segments with parallel and opposing sides **402***a*, **402***b* (or **404***a*, **404***b*) joined by a straight back **402***c* (or **404***c*) that is perpendicular to those opposing sides, and with the juncture of the two opposing sides and back having rounded corners. The tubular coils **402**, **404** are connected by first and second, preferably straight, connecting coil segments **402***d*, **404***d*. Connecting coil segment **402***d* extends from tube **402***a* to tube **404***a* in the adjacent level or layer of the figure eight coils, while second connecting coil segment **404***d* extends from tube **404***b* to tube **402***b* in the adjacent level or layer of figure eight coils. The connecting segments **402***d*, **404***d* are interleaved where they cross between the two coils **402**, **404**. The opposing sides of the coils **204**, **404** are formed by a plurality of coil segments **402***a*, **402***b*, **404***a*, **404***b*, respectively and a majority of the coil segments **402***a* through **402***d* and **404***a* through **404***d* are advantageously parallel and slightly inclined upward to allow for the intersecting segments **402***d*, **404***d*.

As seen in FIGS. **10**A-**10**B, the water reservoir **406** has walls **408***a*, **408***b* and **408***c* enclosing the tubular freezer coils **402**, **404**. Advantageously, coil segments **402***a*, **404***a* are parallel to and connected to opposing ends of the first reservoir side wall **408***a*. Advantageously, coil segments **402***b*, **404***b* are parallel to and connected to opposing ends of the second reservoir side wall **408***b*. Advantageously, coil segments **402***c* are parallel to first reservoir end wall **408***c* while coil segments **404***c* are connected to second, opposing reservoir end wall **408***d*. The reservoir **406** has a top side (not shown as the top is removed) and a bottom side **408***e*.

The connecting segments **402***d*, **404***d* extend between opposing walls **408***a*, **408***b* and extend across the width of the water reservoir **406**. At the location where the connecting segments **402***d*, **404***d* cross each other, the crossing coil segments advantageously form a substantially continuous stack of freezing coil segments **402***d*, **404***d* as seen in FIGS. **9**A and **10**B (the vertical line of circles at the center of the reservoir).

The reservoir walls **408***a-e* form a fluid tight, thermally insulated enclosure with sealed openings for the various fluid connections and electrical connections described with respect to the first embodiment and additional ones for the second chilled water reservoir **414**. The reservoir walls **408***a-e* are advantageously insulated by insulation **410**, with any fluid communications or electrical communications also passing through the insulation as well as the water reservoir. A lid may be removable to allow physical (e.g., repair) access to the inside of the reservoir, but if so, the lid is advantageously sealed to the remaining portions of the water reservoir walls in a fluid tight manner, so water does not leak out the water reservoir.

The single freezer expansion line that is coiled to form the figure eight configuration **401** is shown in FIG. **9**A has an inlet end **411***a* and an outlet end **411***b*. The inlet end **411***a* is in fluid communication with a compressor **70** as shown in FIG. **3**A and the outlet end **411***b* is in fluid communication with a heat exchanger **78** as in FIG. **3**A. In the depicted embodiment the circulation of the refrigerating or freezing fluid (e.g., a Fluro hydrocarbon) is in a direction as shown in FIGS. **9**A and **10**A. The fluid circulation direction of the refrigerating fluid is not believed critical but is described to illustrate the use of a single tube to form the figure eight circulation coil.

Referring to FIGS. **10**A-**10**B, the tubular freezer coils **402** contain chilled water reservoir **412** while tubular freezer coils **404** contain chilled water reservoirs **414**. The tubular freezer coils **402**, **404** freeze the water in the reservoir **406**, which results in a layer or bank of ice **416** forms along the ends and sides **408***a-d* abutting or adjacent to the coil sides **402***a-b*, **404***a-b* and coil ends **402***c*, **404***c*. This is generally referred to as the wall bank **416** of ice. The freezer coils **402**, **404** extend from the bottom **408***e* of the water reservoir **406** to the top of the water line when the reservoir is full and can thus freeze a wall of water from the bottom of the reservoir to the top of the reservoir, along the walls **408***a*, **408***b* of the reservoir to form the wall bank of ice **416**.

But where the connecting segments **402***d*, **404***d* of the evaporator coil **401** approach each other and cross the, the water forms a middle or center ice bank **418**. Depending on the dimensions of the water reservoir **406** and the construction and temperature of the figure eight cooling coil, the middle or center ice bank **418** can advantageously extend entirely across the width of the water reservoir **406**.

The crossing of the connecting segments **402***d*, **404***d* increases the cooling capacity and freezing capacity at the location where the connecting segments cross each other, and as shown in FIG. **10**B, can effectively double the freezing capacity at the crossing location because of the extra ice-bank produced and its thickness. As the angle between the connecting segments increases, the freezing increases at the center and decreases at the outer end adjacent the reservoir walls **408***a*, **408***b*. As the angle at which the connecting segments decreases, the connecting segments are closer together for longer lengths and the freezing capacity increases. Thus, the angle at which the connecting segments **402***d*, **404***d* cross each other may be increased so the connecting segments are further apart along a longer portion of their length in order to decrease the freezing capacity along their length. The angle at which the connecting segments **402***d*, **404***d* cross each other may be reduced so the connecting segments are closer together along a longer portion of their length in order to increase the freezing capacity along a greater portion of their length. Freezing the water between two opposing walls of an elongated reservoir **406** may thus effectively create a center, blocking ice bank **418** formed by the ice frozen by the crossing segments **402***d*, **404***d*. The shape of that center ice bank **418** thus may be varied and may be increased in thickness in a direction between the end walls **408***c* and **408***d* of the water reservoir **406**. An angle of 20°-30° from a plane that is perpendicular to the side walls **408***a*, **408***b* is believed suitable for a water reservoir having a width between those sidewalls of 10-15 inches. As the distance between the sidewalls **408** increases, the angle usually decreases and approaches smaller angles of 10-20° for larger water reservoir widths with sidewalls further apart.

Referring to FIG. **10**A, the shape of the ice bank **416** along the side walls **408***a*, **408***b* and end walls **408***c* and **408***d* is preferably a uniform thickness X—except at the location of the center ice bank **418**. Advantageously, the center ice bank **418** has a thickness that is at least twice the thickness of the wall ice bank, and advantageously from 2-4 times as thick along a substantial majority of its width and height. The center ice bank **418** advantageously has a substantially uniform thickness along its height, which advantageously extends from the bottom **408***e* of the water reservoir **406** to the top of the water level in the reservoir.

As seen in FIGS. **10**A-**10**B, first and second drinking water chilled coils **422**, **424** preferably made of stainless steel, are located inside respective first and second tubular freezing coils **402**, **404** and the respective first and second chilled water reservoirs **412**, **414**. The ice banks **416**, **418** advantageously encircle the drinking water chiller coils **422**, **424** and preferably the inward facing side of the ice banks **416**, **418** are separated from the outward facing side of the drinking water chiller coils **422**, **424** by a distance that is the same around a majority of the area of the ice banks and chilling coils that face each other, and that is preferably the same around a substantial majority of the area of the ice banks and drinking water chiller coils that face each other. The chilled water circulation is achieved by agitators as described previously, with the ice banks **416**, **418** controlled by temperature sensors for each tank as described previously. Advantageously, two ice temperature sensors are used, one for each chilled water reservoir **412**, **414** to ensure the thickness of the center ice bank **418** is the same in each chilled water reservoir. But it is believed suitable, but less desirable, to have only one ice sensor in either one of the chilled water reservoirs **412** or **414**. The control of the various components associated with the figure eight coil **401** is as described regarding FIGS. **1** and **8**, using controller **64** to coordinate and control the various components.

A refrigeration system with the figure eight coil **401** provides a larger volume of chilled water than does the single coil freezer design, while doing so with a single compressor and expansion coil. Moreover, the center ice bank **418** can be thicker in the end-to-end direction between reservoir walls **408***c* and **408***d* because the connecting segments **402***d*, **404***d* of the freezer coils **402**, **404** may be configured to create a thicker ice bank in that direction. The thicker center ice bank **418** allows a larger reserve of ice to melt if the chilled water in the reservoirs **412**, **414** becomes warm because of high demand resulting in high flow of water through the two drinking water chiller coils **420**, **422**. The melting ice banks **416**, **418** provide a thermal reserve to stabilize temperature variations as the ice melts when the water in the chilled water heats up and the melting ice. The thicker center ice bank **418** thus allows more temperature stability in the chilled water contained inside each chilled water reservoir **412**, **414**.

Referring to FIGS. **1**A and **1**D, Filter Reset (FR) button **147** (FIG. **1**D) is used to reset a timer whose clock is included in controller **64**. The FR button **147** resets the dispensing volume total value (determined by flow meter **88**). These resets may be automatically done every time an old water filter **32**, **130** is replaced by a brand-new water filter, regardless of whether the water filter is externally accessible (filter **32**) or internally located (e.g., filter **130**). During use of the beverage dispenser, controller **64** registers and stores information concerning the time the dispenser has been in operation (i.e., powered on). Contemporaneously, flow meter **88** measures the total volume of water the same apparatus has dispensed and because flow meter **88** is in electrical communication with the controller **64**, the information may be readily processed by the controller **64**. When either the clock has reached a specific time setting associated with replacing the water filter (normally six months), or whether the flow meter has detected a total volume of water dispensed (normally six thousand gallons), which of the two separate thresholds is reached first, the controller sends a signal to the filter indicator **62** (FIG. **1**A) and the indicator starts blinking (e.g., a LED indicator light starts blinking). By pressing and holding the FR button **147** (FIG. **1**D) for a number of seconds, both the clock and the volume metering counter in the controller **64** are reset to zero and the cycle repeats. Normally FR button **147** is pressed anytime water filters **32**, **130** and alkaline chambers **132** are changed and the FR button **147** and controller **64** may be used to track the use of each, and send a signal to an indicator (e.g., indicator **64**) to notify users that replacement is needed.

Referring to FIG. **6**A, hot water tank **152** has a heater, or heating element **154**, inside the hot water reservoir. Heater **154** may have a stainless-steel shirt or encasement, preferably made of AISI 304, or preferably AISI 3016 stainless steel. Because of the particular makeup of these stainless steels, there is limited scaling build up and no rust over time. In addition, the presence of the NTC thermistor **156** is positioned at less than 2 mm distance (preferably 0.5 mm to 1.0 mm) distance from the heating element **154** allow a precise monitoring of the heat transfer from the heating element. Heat is believed to be mainly transferred from the heating element **154** to the water inside the hot water reservoir by conduction and convection, and in case of low water or no water inside the hot water reservoir the heat is believed to be transferred mainly by radiation. A sensor **156** having a NTC sensor can accurately monitor the temperature; due to its proximity to the heating element **154** and the heat transferred from such heating element to the surrounding environment and to sensor **156**. In case of low or no water inside the tank, the maximum temperature the hot tank is exposed to is believed to be the same as in the case where the hot water tank is full of water. The cycling between the maximum temperature setting and the minimum temperature setting of the hot water tank will be longer in case of low or no water inside the hot tank because air transfers or conducts heat at a slower rate than does water. But it is believed that the hot water tank **152** can operate for long time without thermally degrading the heating element **154** even when water is totally evaporated from the hot water tank as may arise when the dispensing apparatus has not been in use.

The electronic control module **64** of the beverage dispensing apparatus also allows a user at any time to change the “factory window setting” of the three main NTC temperature sensors **156**, **180** and **182**. By commands directed to the controller **64**, the setting of the either or both the maximum temperature and the minimum temperature of each of the three main temperature sensors may be changed. Each of these three temperature sensors **156**, **180** and **182** control the operation of other components to maintain temperatures at the location of the sensor between a maximum and a minimum setting points. Sensor **156** advantageously operates from 96° C. and 80° C.; sensor **180** advantageously operates from 0.6° C. and 1.2° C.; and sensor **182** operates from 0.4° C. and −1.8° C. Each of the above settings can be modified manually by holding the FR button **147** for a predetermined minimum time (e.g., more than 10 seconds) until the buttons **52**, **54**, **56** and **58** start flashing and, by touching each of them, in accordance with a predetermined software code, user can selectively change, increasing or reducing the max and min temperature settings of each of the temperature sensors **156**, **180** and **182**. By changing the temperature setting of sensor **156**, a user can increase the temperature of the hot water dispensed by the apparatus in accordance with personal preferences. By changing the temperature setting of sensor **180**, a user can produce less ice or more ice, for example making the apparatus produce a lot of extra ice to build a thicker ice-bank which provides a larger energy storage and a lot of latent heat to meet a high consumer demand, as may arise when the apparatus is installed in a busy restaurant during rush hour. By changing the temperature setting of sensor **182**, one can vary the setting temperatures of the agitator pump **170**, allowing, for example, the agitator pump to work in a larger range of temperatures and extract more heat from the ice bank, as may arise when the apparatus is installed in a busy restaurant compared to a residential home.

The above description is given by way of example, and not limitation. Given the above disclosure, one skilled in the art could devise variations that are within the scope and spirit of the invention, including various ways of varying the dimensions such as the angle of the crossing freezer coil segments **402***d*, **404***d*. A number of valve types are believed suitable for use for the various valves described herein, including solenoid valves. Further, the various features of this invention can be used alone, or in varying combinations with each other and are not intended to be limited to the specific combination described herein. Thus, the invention is not to be limited by the illustrated embodiments.

What is claimed is:

1. A beverage dispensing apparatus, comprising:

a housing;

a heat exchanger arranged within the housing and comprising a reservoir configured to store a heat exchange fluid;

an agitator arranged within the reservoir and configured to circulate the heat exchange fluid within the reservoir;

a chiller coil configured to circulate a beverage, wherein at least a portion of the chiller coil is arranged within the reservoir and is configured to be submerged in the heat exchange fluid;

a refrigeration system comprising an evaporator coil, wherein the evaporator coil is arranged within the reservoir, wherein the evaporator coil is configured to circulate a refrigerant to form an ice bank in the reservoir around the evaporator coil;

a spigot in communication with the chiller coil for dispensing the beverage;

a temperature sensor arranged within the reservoir and configured to detect a temperature of the heat exchange fluid within the reservoir; and

a controller in communication with the temperature sensor and the refrigeration system, wherein the controller is configured to operate the refrigeration system based on the temperature detected by the temperature sensor.

2. The beverage dispensing apparatus of claim **1**, wherein the controller is configured to deactivate the refrigeration system when the temperature detected by the temperature sensor reaches a predetermined low temperature.

3. The beverage dispensing apparatus of claim **1**, wherein the temperature sensor is configured to detect growth of the ice bank based on the detected temperature of the heat exchange fluid.

4. The beverage dispensing apparatus of claim **1**, wherein the temperature sensor is arranged a predetermined distance from the evaporator coil so as to detect growth of the ice bank around the evaporator coil.

5. The beverage dispensing apparatus of claim **1**, wherein the evaporator coil is arranged along an inner wall of the reservoir.

6. The beverage dispensing apparatus of claim **5**, wherein the evaporator surrounds at least a portion of the chiller coil.

7. The beverage dispensing apparatus of claim **1**, wherein the temperature sensor comprises a thermistor.

8. A beverage dispensing apparatus, comprising:
- a housing;
- a heat exchanger arranged within the housing and comprising a reservoir configured to store a heat exchange fluid;
- an agitator arranged within the reservoir and configured to circulate the heat exchange fluid within the reservoir;
- a chiller coil configured to circulate a beverage, wherein at least a portion of the chiller coil is arranged within the reservoir and is configured to be submerged in the heat exchange fluid;
- a refrigeration system comprising an evaporator coil, wherein the evaporator coil is arranged within the reservoir, wherein the evaporator coil is configured to circulate a refrigerant to form an ice bank around the evaporator coil;
- a spigot in communication with the chiller coil for dispensing the beverage;
- a first temperature sensor arranged within the reservoir and configured to detect a temperature of the heat exchange fluid within the reservoir;
- a second temperature sensor configured to detect a temperature of the beverage in the chiller coil; and
- a controller in communication with each of the first temperature sensor, the second temperature sensor, the agitator, and the refrigeration system,
- wherein the controller is configured to operate the refrigeration system based on the temperature of the heat exchange fluid as detected by the first temperature sensor, and wherein the controller is configured to operate the agitator based on the temperature of the beverage in the chiller coil as detected by the second temperature sensor.

9. The beverage dispensing apparatus of claim **8**, wherein the agitator comprises a submersible pump.

10. The beverage dispensing apparatus of claim **8**, wherein the second temperature sensor is arranged within the reservoir adjacent to the chiller coil.

11. The beverage dispensing apparatus of claim **8**, wherein the controller is configured to deactivate the refrigeration system when the temperature detected by the first temperature sensor reaches a first predetermined low temperature.

12. The beverage dispensing apparatus of claim **11**, wherein the controller is configured to deactivate the agitator when the temperature detected by the second temperature sensor reaches a second predetermined low temperature.

13. The beverage dispensing apparatus of claim **8**, wherein the evaporator coil is arranged along an inner wall of the reservoir.

14. The beverage dispensing apparatus of claim **13**, wherein the evaporator coil surrounds at least a portion of the chiller coil.

15. A method of controlling a temperature of a beverage within a beverage dispenser, the method comprising:
- storing a quantity of heat exchange fluid in a reservoir of a heat exchanger of the beverage dispenser;
- circulating the beverage through a chiller coil, wherein the chiller coil is arranged within the heat exchanger;
- circulating a refrigerant through an evaporator coil of a refrigeration system, wherein the evaporator coil is arranged within the reservoir and is configured to form an ice bank within the reservoir;
- detecting a temperature of the heat exchange fluid by a first temperature sensor arranged within the reservoir; and
- operating a compressor of the refrigeration system based on the temperature of the heat exchange fluid as detected by the first temperature sensor.

16. The method of claim **15**, wherein operating the refrigeration system comprises deactivating the compressor of the refrigeration system when the temperature of the heat exchange fluid as detected by the first temperature sensor reaches a predetermined low temperature.

17. The method of claim **15**, further comprising:
- detecting a temperature of the beverage within the chiller coil by a second temperature sensor; and
- operating an agitator arranged within the reservoir of the heat exchanger based on the temperature detected by the second temperature sensor.

18. The method of claim **17**, wherein operating the agitator comprises deactivating the agitator when the temperature of the beverage within the chiller coil reaches a predetermined low temperature.

19. The method of claim **18**, further comprising reactivating the agitator, after deactivating the agitator, when the temperature of the beverage within the chiller coil increases to a second predetermined temperature that is greater than the predetermined low temperature.

20. The method of claim **17**, wherein operating the agitator comprises adjusting a speed of the agitator based on the temperature of the beverage as detected by the second temperature sensor.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 12,122,654 B2
APPLICATION NO. : 18/048750
DATED : October 22, 2024
INVENTOR(S) : Fantappie et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

In Column 57, Claim 6, Line 17, delete “surrounds” and insert --coil surrounds-- therefor.

Signed and Sealed this
Third Day of December, 2024

Katherine Kelly Vidal

Katherine Kelly Vidal
Director of the United States Patent and Trademark Office